ANNALS

OF THE

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VOLUME VII.

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SOUTH AFRICAN MUSEUM

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LIST OF NEW GENERIC NAMES

INTRODUCED IN THIS VOLUME.

INDEX OF GENERA AND SPECIES.

1.—*Polyzoa and Anthozoa from the Upper Cretaceous Limestone of Need's Camp, Buffalo River.*—By W. D. Lang, M.A., F.G.S., British Museum (Natural History).

Plate I.

The rock containing the Polyzoa here described, is so full of them in places that they compose the rock nearly to the exclusion of its other components. Such pieces closely resemble in general appearance specimens of a rock composed mainly of Polyzoa from the Danian of Faxoe, in the island of Seeland, Denmark. Moreover, in both rocks the surfaces of the specimens are very ill-preserved, being rough, with the details ill-defined, as though the specimens were covered with a thin incrustation. And in both the large proportion of erect, cylindrical Polyzoa is remarkable.

The species described below range from the Neocomian to the Danian, and the majority are restricted to the Chalk. In so far as it is possible to assign a definite horizon to the deposit on the evidence of the Cyclostome Polyzoa only, it appears that its age is Senonian or Danian.

DIASTOPORIDÆ.

Genus FILISPARSA, d'Orbigny.

Gregory * places this genus among the Diastoporidæ because of its resemblance to *Proboscina*. He says it may be regarded as "a group of *Proboscinæ* with an erect habit"; and goes on to show how some species of *Filisparsa* correspond with some of *Proboscina*. But he also points out that Pergens † placed the genus in the Idmoneidæ. The nature of the zoarium and distribution of the zoœcia are such that the genus occupies an intermediate place

* J. W. Gregory, B.M. Cat. Cret. Bryozoa, vol. i., 1899, p. 67.

† E. Pergens, Rev. de Bry. du Cret. fig. par d'Orb., Bull de la Soc. Belge de Geol., iii., 1890, Mem., p. 339.

between the two families; and thus it shows the probability of the present classification of the Cyclostome Polyzoa being highly artificial. But until the distribution and life history of each described form has been determined, it is impossible to form a natural classification of the whole. Meanwhile, the present artificial classification must be used for lack of better.

Filisparsa ramosa, d'Orbigny.

Plate I., fig. 1.

1853. *Filisparsa ramosa*, d'Orbigny, Bry. Crét., p. 819, pl. 756 figs. 18–22.

Zoarium of erect, flattened, solid branches, in one plane. Zoœcia only opening on one face of the zoarium. Apertures tend to arrangement in V-shaped bands across the zoarium, but their distribution is somewhat irregular; four or five in a series; distance between apertures of the same series one-half times to once the diameter of an aperture; between apertures of neighbouring series twice to four times. Zoœcia immersed.

There are three fragments of this species, one of which is figured.

Distribution. Turonian and Senonian.

Filisparsa fragilis, Marsson.

Plate I., fig. 2.

1887. *Filisparsa fragilis*, Marsson, Bry. Rüg.; Pal. Abh., vol. iv., p. 35, pl. iii., fig. 8.

Zoarium of erect, cylindrical, or slightly flattened solid branches, in one plane. Zoœcia only opening on one face of the zoarium. Apertures arranged in single series across the zoarium; four or five in a series; distance between apertures of the same series one-half times or less the diameter of an aperture; between those of neighbouring series twice-and-a-half to thrice. Zoœcia immersed, but the boundaries between them are more or less apparent as ridges. One fragment out of seven is figured.

Distribution. Senonian.

Genus DIASTOPORA, Lamouroux.

Diastopora is here used, as in the British Museum Catalogue, for Diastoporidæ with an erect uni-, bi-, or even multi-laminar zoarium, consisting of fronds or of very flattened branches.

DIASTOPORA COMPRESSA (Goldfuss).

Plate I., fig. 3.

1827. *Ceriopora compressa*, Goldfuss, Petref. Germ., p. 37, pl. xi., fig. 4.

1851. *Ditaxia compressa*, von Hagenow, Bry. Maastr. kr., p. 50, pl. iv., fig. 10.

Zoarium of erect bilaminar fronds. Zoœcia immersed, and their boundaries not apparent, or very slightly so. Apertures irregularly arranged; the distance between the apertures in a proximal-distal direction is about once the diameter of an aperture; that in a direction at right angles to the last is once or less than once the diameter of an aperture. This definition does not distinguish *D. compressa* from *Mesenteripora Hyselyi*, de Loriol (Urg. Land.: Mém. Soc. helv. Sci. Nat., vol. xxiii., 1869, p. 40, pl. iii., fig. 1), from the Urgonian of Neuchatel; and from the figures it is difficult to see any difference between these two forms. But fig. 10 *m.* on pl. iv. of von Hagenow's work shows a piece of a zoarium with the apertures elongate in a proximal-distal direction. It is only described in the legend "Theil der Oberfläche am oberen Rande," but it looks as if this were a worn surface and the elongation of the apertures were due to the angle between the surface and the direction of the zoœcia at that level. It is possible that in *M. Hyselyi* the direction of the zoœcia would be perpendicular to the surface for some distance, in which case a worn specimen would show circular apertures.

D'Orbigny's figure of *Bidiastopora Campicheana* (Bry. Crét., 1853–4, p. 800, pl. 784, figs. 6 and 8) also resembles *Diastopora compressa* and *Mesenteripora Hyselyi*. But Pergens, who has seen d'Orbigny's specimens, identifies *B. Campicheana* with *B. acuta*, d'Orbigny, and re-figures the latter (Revision des Bry. Crét. fig. par d'Orbigny, 1890, pl. xi., fig. 7), showing it to be a form quite distinct from *D. compressa* and *M. Hyselyi*.

Gregory places as synonyms of *Diastopora compressa* the two forms figured by d'Orbigny as *Mesenteripora compressa* and *M. neocomiensis* (Bry. Crét., 1853–4, pl. 756, figs. 10–13 and 7–9); but both these forms have emergent zoœcia.

Among the material described the only specimen referable to this species is a small fragment of the base of a frond. The earliest zoœcia, as would be expected, differ from the later ones; they are further apart and slightly emergent. Near the edge of the fragment they are seen to be close together and immersed, with their boundaries slightly shown. The apertures, especially near the edge,

where they are slightly worn, are somewhat elongated in a proximal-distal direction.

Distribution. Senonian.

IDMONEIDÆ.

Genus IDMONEA, Lamouroux.

Idmonea virgula, d'Orbigny.

Plate I., fig. 4.

1851. *Idmonea virgula*, d'Orbigny, Bry. Crét., pl. 631, figs. 15–17.
1863. *Reptotubigera simplex*, de Loriol, Invert. Mt. Salève, p. 127 pl. xvi., fig. 3.

Zoarium of a single zoœcium-bearing ridge, without a selvage short (about thrice as long as broad), rapidly becoming broader distally. The only specimen of this species has a flat reverse face, but does not encrust any object. But its general shape and correspondence with d'Orbigny's figure of *Idmonea virgula* renders it probable that it was originally encrusting some perishable object which has since decayed. This raises the question whether other Idmoneidæ with flat or convex reverse faces, such as *Crisina marginata*, d'Orbigny, in some cases may not have been forms encrusting some object, such as seaweed, which has since perished.

Distribution. Neocomian and Cenomanian.

Genus CRISINA, d'Orbigny.

The separation of *Crisina* from allied Idmoneid genera, especially from *Retecava*, is attended with much difficulty.* The genus is here used as restricted by Gregory,† and distinguished from *Tervia* and *Reticrisina*, which Gregory regards as subgenera. *Tervia* is here considered as equal to *Crisina* in systematic significance. *Crisina* thus regarded may be defined as a genus of Idmoneidæ, in which the zoarium is erect, and consists of solid branches, which are subcylindrical or moderately compressed; the reverse face is well developed, but does not overlie an "axial rod" as in *Retecava*; there is no unpaired median nor multiple median series of apertures on the obverse face; the apertures are in single lateral series, and circular.

* See W. D. Lang, Geol. Mag., 1907, p. 125.
† J. W. Gregory, Brit. Mus. Cat. Cret. Bry., 1899, vol. i., pp. 159, 168, and 176.

CRISINA CENOMANA, d'Orbigny.

Plate I., fig. 5.

1851. *Crisina cenomana*, d'Orbigny, Bry. Crét., p. 732, pl. 614, figs. 1–5.

1845. *Idmonea disticha*, Michelin, Icon. Zooph., p. 204, pl. lii., fig. 18.

1853. *Idmonea calypso*, d'Orbigny, Bry. Crét., p. 733, pl. 747, figs. 10–14.

1890. *Idmonea cenomana*, Pergens, Revision des Bry. Crét. fig. par d'Orbigny, p. 344, pl. xii., fig. 3.

Zoarium subcylindrical, and the reverse face is convex or flat; there is no keel on the obverse face; the zoœcia are immersed, and when the reverse face is flat the zoœcial boundaries are clearly marked; the lateral series of apertures are quite regular, and just reach the middle line of the obverse face; there are about four apertures in each lateral series; the apertures are circular, all of one size; those of the same series are distant less than one diameter of an aperture; those of different series two or three diameters of an aperture.

This definition distinguishes *C. cenomana* from all cretaceous forms of *Retecava* as well as from others of *Crisina*. Those species of *Retecava* which most resemble it have a very slight median keel on the obverse face, except *R. Abbotti* (Gabb and Horn), (Journ. Acad. Nat. Sci. Philadelphia, ser. ii., vol. iv., 1860, p. 404, pl. lxix., figs. 45–47), but in this form there is a ridge down the obverse face of each zoœcium.

Two distinct forms are included under the above definition, and both occur in the material here described. In the first, resembling d'Orbigny's figure of *C. cenomana*, the zoœcial boundaries are hardly visible and the reverse face is convex. In the second (pl. xlv., fig. 4), resembling d'Orbigny's figure of *Idmonea calypso*, the zoœcial boundaries are strongly marked and the reverse face is flat. The only justification for placing the two forms under one name is their identification by Pergens.* Speaking of *C. cenomana*, under the synonyms of which he had placed *I. calypso*, Pergens says, "quelquefois les branches sont aplaties à la partie inférieure et forment ainsi une variété décrite comme *I. calypso*." That is, *I. calypso* is an earlier growth stage of *C. cenomana* confined to the proximal portions of the zoarium. In view of the very fragmentary character of the specimens usually obtained of these erect Idmoneids,

* E. Pergens, Revision des Bry. Crét. fig. par d'Orbigny, 1890, p. 344.

it is exceedingly rare to get knowledge of the growth stages of any one form. But the specimens of *C. cenomana* here described do not look like proximal ends of zoaria. It is likely, then, that a form exists whose adult zoarium over its greater extent has the characters of *I. calypso*, d'Orbigny, while these are confined to the proximal parts of an adult zoarium of *C. cenomana*.

Distribution of both *C. cenomana* and *I. calypso*. Cenomanian.

Crisina excavata (d'Orbigny).

Plate I., fig. 6.

1853. *Idmonea excavata*, d'Orbigny, Bry. Crét., p. 742, pl. 749, figs. 11–15.

Zoarium subtriangular with a flat or concave reverse face; the lateral series are regular and contain six to eight apertures; the apertures are circular; the zoœcia are emergent. *Idmonea filiformis*, d'Orbigny (Bry. Crét., 1853, p. 744, pl. 750, figs. 1–5), and *Idmonea lata*, d'Orbigny (Bry. Crét., 1853, p. 734, pl. 748, figs. 6–10) resemble this form, but have only three apertures in a lateral series. *Idmonea marginata*, d'Orbigny (Bry. Crét., 1853, p. 744, pl. 749, figs. 20–23), with which Gregory unites this form, differs from it by having immersed zoœcia.

Distribution. Senonian.

Crisina marginata (d'Orbigny).

Plate I., fig. 7.

1853. *Idmonea marginata*, d'Orbigny, Bry. Crét., p. 744, pl. 749, figs. 20–23.

1853. *Idmonea angulosa*, d'Orbigny, Bry. Crét., p. 735, pl. 748, figs. 11–15.

Zoarium subtriangular with a flat or convex reverse face; the lateral series are regular and each contains four or five apertures; the apertures are circular. This form is very like *C. excavata* (d'Orbigny), but has fewer apertures in a lateral series, and the zoœcia are immersed.

Distribution. Turonian and Senonian.

Genus TERVIA, Jullien.

Idmoneidæ whose zoarium is erect and consists of solid branches. There is an unpaired median series of apertures between the two rows of simple lateral series. *Tervia* is considered by Gregory as a

subgenus of *Crisina*, from which it differs in possessing a simple median series of apertures on the obverse face. The fact that it is not always easy to distinguish this series as composed of apertures distinct from the most median apertures of the lateral series shows the artificiality of the genus. This point is well exemplified in von Hagenow's figure of *T. dorsata* (von Hagenow).

Tervia dorsata (von Hagenow).

Plate I., fig. 8.

1851. *Idmonea dorsata*, von. Hagenow, Bry. Maastr. kr., p. 31, pl. ii., fig. 10.

Zoarium subcylindrical or triangular or flattened in a plane parallel to the obverse and reverse faces; without dorsal processes; reverse face flat or concave; zoœcia three or four in a lateral series, immersed but the boundaries are clearly marked; the distance between the different series of apertures is one and a half to two and a half times the diameter of an aperture; those of the same series are distant about a quarter the diameter of an aperture. This is the commonest form among the specimens of Cyclostomes from Need's Camp.

Distribution. Senonian.

Tervia gibbera, Gregory.

Plate I., fig. 9.

1899. *Crisina* (*Tervia*) *gibbera*, Gregory, Brit. Mus. Cat. Cret. Bry., vol. i., pp. 173–4, Text fig. 12.

Zoarium subcylindrical with the reverse face flat and possessing spine-like projections, bearing no zoœcia, termed by Gregory "dorsal processes"; zoœcia about three in a lateral series, immersed, but the boundaries are just shown; distance between the different series of apertures three to four times the diameter of an aperture; those of the same series distant about one-half the diameter of an aperture. Only two specimens have been found among the material here described.

Distribution. Senonian.

Tervia decurrens (Pocta).

1892. *Idmonea decurrens*, Pocta, Mech. koryc. Hory.; Ceska. Ak. Fr. Jos. Pratze, sect. 2, p. 18, pl. ii., figs. 3–6.

Zoarium subtriangular in cross-section and flat on the reverse side; the zoœcia are immersed with their boundaries apparent; apertures

two or three in a lateral series; those of different series distant four or five diameters of an aperture, those of the same series two to three diameters of an aperture.

A single specimen is somewhat doubtfully referred to this species. It is the proximal end of a zoarium, though the first few zoœcia appear to be missing. Beginning as a thin, cylindrical branch, the zoarium rapidly widens and becomes compressed in a plane parallel to the obverse and reverse faces, at the same time becoming very curved, so that in a section along the proximal-distal axis the obverse face appears convex and the reverse face concave. When the breadth of the zoarium has reached about one-third of its length, it divides into two subcylindrical branches; one of these is broken off short, but the other continues for about 1·5 mm., without altering in shape. It would be interesting to know if on further growth the branches flatten and widen, thus recapitulating the growth stages of the first part of the zoarium;* or whether the first part is really an encrusting portion, whose support has decayed, which has thrown up cylindrical branches in the same way as a *Phalangella*-like base has been shown by Gregory † to throw up branches of the genus *Crisina*. The general zoœcial characters are those of *Tervia decurrens* (Pocta), in which species it is provisionally placed.

Distribution. Cenomanian.

ENTALOPHORIDÆ.

Genus ENTALOPHORA, Lamouroux.

Entalophora virgula (von Hagenow).

Plate I., fig. 10.

1840. *Ceriopora virgula*, von Hagenow, Mon. Rüg.: Neu. Jahrb., 1840, p. 646.

1851. *Pustulipora virgula*, von Hagenow, Bry. Maastr. kreide., p. 17, pl. i., fig. 3.

Zoarium consisting of smooth cylindrical branches; the apertures are irregularly distributed on the zoarium and are very far apart, their distance apart in a proximal-distal direction being generally more than four times the diameter of an aperture. There are never more than two apertures in the breadth of a branch. The zoœcia

* See W. D. Lang, Geol. Mag., 1905, pp. 259–260.

† J. W. Gregory, Brit. Mus. Cat. Cret. Bry., vol. i., 1899, p. 159, text-fig. 11.

are immersed. *Entalophora Pergensi*, Gregory,* which the above definition would also include, has thinner branches and the apertures still further apart than in *E. virgula.*

This is the commonest species of Cretaceous *Entalophora* and has been found in most of the localities whence Cretaceous Polyzoa have been recorded; but only one specimen has been found among the material here described.

Distribution. Neocomian–Danian.

Entalophora conjugata, von Reuss.

Plate I., fig. 11.

1872–3. *Entalophora conjugata*, von Reuss, Bry. unt. Quad. Palæontogr., vol. xx., part. i., p. 117, pl. xxix., fig. 8.

Zoarium consisting of cylindrical branches; the apertures are distant from one another in a proximal-distal direction more than four times the diameter of an aperture; the apertures occur in rows of two or three across the branch; the zoœcia are immersed and their boundaries may be faintly marked. This form is very like *E. geminata* † (von Hagenow), but the zoœcia are shorter, the boundaries of the zoœcia are less clearly marked, and the apertures occur in groups of three instead of two as in *E. geminata.* A single specimen of this species occurs among the material here described.

Distribution. Cenomanian.

Entalophora echinata (Römer).

Plate I., fig. 12.

1840. *Pustulopora echinata*, Römer, Verst. Nordd. kr., p. 22, pl. v., fig. 23.

1846. *Pustulopora echinata*, von. Reuss., Verst. Böhm kr., p. 64, pl. xiv., fig. 4.

Zoarium consisting of cylindrical branches; the apertures are distant from one another in a proximal-distal direction about four diameters of an aperture. There are about four apertures in the breadth of a branch; the diameter of the apertures is about 2 mm.; the zoœcia are immersed, with their boundaries more or less apparent. This species is very nearly allied to *E. madreporacea* (Goldfuss), from which it differs in having the apertures slightly further apart in a proximal-distal direction, the zoœcial boundaries more prominent,

* J. W. Gregory, Brit. Mus. Cat. Cret. Bry., vol. i., 1899, p. 226, pl. x., figs. 5, 6, 7.

† *Pustulipora geminata*, von Hagenow, Bry. Maas. kr., 1851, pl. i., fig. 11, p. 20.

and the apertures less regularly arranged. The peristomes, too, are higher; but in the three specimens of this species among the material here described the peristomes are worn.

Distribution. Cenomanian to Danian.

Entalophora madreporacea (Goldfuss).

Plate I., fig. 14.

1827. *Ceriopora madreporacea*, Goldfuss, Petref. Germ., p. 35, pl. x., figs. 12*a* and *b*.

1851. *Pustulipora madreporacea*, von. Hagenow, Bry. Maastr. kr., p. 18, pl. i., fig. 8.

Zoarium consisting of cylindrical branches; the apertures are distant from one another in a proximal-distal direction less than four diameters of an aperture; there are four to six apertures in the breadth of a branch; the apertures are somewhat irregularly arranged in spirals; the zoœcia are immersed. Three ill-preserved specimens from among the East London material are doubtfully referred to this species. All are very short fragments of stout branches, and, in so far as the zoœcial characters can be determined, resemble *E. madreporacea* more closely than any other form.

Distribution. Cenomanian to Danian.

Genus SPIROPORA, Lamouroux.

Spiropora should probably be united with *Entalophora*, for in many species of the latter genus the apertures are arranged spirally. *Spiropora*, however, may be defined as resembling *Entalophora*, but the apertures are arranged in whorls, or, if in spirals, these are very much looser than in *Entalophora*.

Spiropora verticillata (Goldfuss).

Plate I., fig. 13.

1827. *Ceriopora verticillata*, Goldfuss, Petref. Germ., vol. i., p. 36, pl. xi., fig. 1.

1851. *Cricopora verticillata*, von Hagenow, Bry. Maastr. kr., p. 20, pl. i., fig. 12.

Zoarium consisting of cylindrical branches, having the apertures arranged in whorls; there are five to ten apertures in the breadth of a branch; the whorls are distant four or five diameters of an aperture; the distance between the apertures of a whorl is a half or less than a half the diameter of an aperture; the zoœcia are immersed, but the

boundaries between them are clearly marked by thin ridges. Next to *Tervia dorsata* (von Hagenow), this is the commonest species of Cyclostome among the material here described.

Distribution. Neocomian to Danian.

Anthozoa.

In the Need's Camp material are several specimens of simple corals, thickly encrusted with Cheilostome Polyzoa. Transverse sections show that they belong to the genus *Caryophyllia*, but the species cannot be determined owing to their encrusted condition.

2.—*Echinoidea, Brachiopoda, and Lamellibranchia from the Upper Cretaceous Limestone of Need's Camp, Buffalo River.*—By HENRY WOODS, M.A., University Lecturer in Palæozoology, Cambridge.

Plate I. and three figures in text.

AN account of the deposit from which the fossils here described were obtained is given at the end of this paper (page 425). The large specimens of *Perna* were found in the hard crystalline limestone; most of the other fossils came from the polyzoa-limestone. No species giving decisive evidence of the horizon of the limestone has been recognised, but the affinities of the forms described seem to show that the deposit belongs to a late stage of the Chalk.

ECHINOIDEA.

COPTOSOMA CAPENSE, sp. nov.

Plate I., figs. 15–17. Text-figure 1.

Test of medium size, with sub-circular outline, convex above, flattened below, somewhat concave around the peristome; height equal to less than half the diameter; greatest diameter in the lower third.

Apical disc rather small, not preserved.

Ambulacra not quite as wide as the interambulacra. Poriferous zones undulating. Pores unigeminal, except on the base of the test, where they are bigeminal. Plates high, consisting of six fused plates, with the six pairs of pores forming an arc. Each compound plate bears a large primary, imperforate tubercle (either very slightly or not at all crenulate), with a large areola, and a few small tubercles and granules around the margin. The primary tubercles are largest

at the ambitus, and smaller on the dorsal surface and on the base of the test.

Interambulacral plates high, each bearing a large primary, imperforate, slightly crenulate tubercle with an areola of moderate size; these tubercles are largest at the ambitus, where they are surrounded by a narrow band of small tubercles and granules. Above the ambitus, and on the base of the test, the primary tubercles become smaller; above the ambitus the surrounding band of granules becomes much wider. At the ambitus and continued on to the base of the test there is a row of secondary tubercles at the external margin of the area.

Peristome of moderate size.

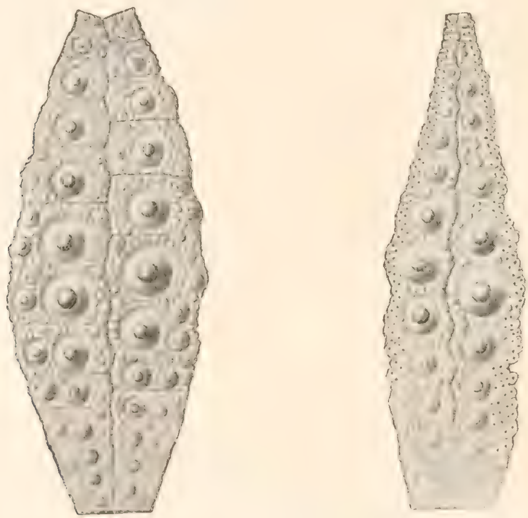

Fig. 1.—*Coptosoma capense*, sp. nov. Ambulacral and interambulacral areas. × 2.

The bigeminal pores extending from the peristome almost to the margin of the base seem to distinguish this from other species of *Coptosoma*. The form of the test is similar to that of the type species, *C. cribrum*, Desor, but the granules, especially on the interambulacral areas, are much more extensively developed.

Portions of three tests have been found, the largest and most perfect of which is here figured. In all cases the apical disc is missing.

The only other remains of echinoids found in this deposit are some strongly ridged spines of *Cidaris*, and a portion of the test of an irregular form which may perhaps belong to *Cassidulus*.

BRACHIOPODA.

Thecidea (Lacazella), sp.

Text-figure 2.

The ventral valve is deep, more or less conical but sometimes rather irregular, and either slightly curved or nearly straight. The area is large and triangular, with a raised pseudo-deltidium. On the exterior of the shell are growth-ridges parallel to the margin of the valve. In the interior of the valve are narrow longitudinal ridges.

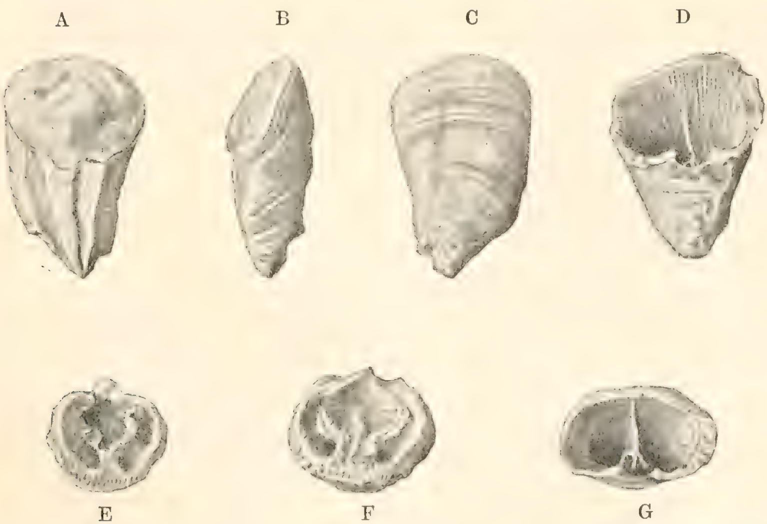

Fig. 2.—*Thecidea* (*Lacazella*), sp. A, B, C, three views of the same specimen; D, G, a ventral valve seen from the cardinal side (D) and from the dorsal surface (G); E, F, two dorsal valves. All × 3.

The thin median septum is joined by a short branch on each side near the cardinal margin. This valve is deeper and less curved than in most examples of *Thecidea vermicularis* (Schlotheim),* but is not so deep as in *T. longirostre*, Bosquet.†

* For figures and references see Geinitz, Das Elbthalgeb. in Sachsen (Palæontographiça, vol. xx., pt. 1, 1872), p. 162, pl. xxxv., figs. 35–38. Bosquet, Brach. Terr. Crét. Supér. de Limbourg (1859), p. 26, pl. iii., figs. 4–11. Posselt, Brach. danske Kridtformat. (Danmarks geol. Undersög., Nr. 6, 1894), p. 53, pl. iii., figs. 23–25.

† Bosquet, *op. cit.*, p. 33, pl. iv., figs. 4–6

The dorsal valve is oval, slightly convex, with the umbo near the margin. The internal margin is ornamented with ridges. From the median septum one or sometimes more branches come off on each side.

Several examples of this species were found by Mr. Lang when searching for Polyzoa in the broken-up rock.

LAMELLIBRANCHIA.

OSTREA, sp.

A small specimen of part of a left valve is probably an example of *O. vesicularis*, Lamarck.* That species occurs in the Ariyalúr Group of Southern India, and is widely distributed in deposits of Senonian age.

Some other examples of *Ostrea*, but not sufficiently perfect for specific determination, have been found.

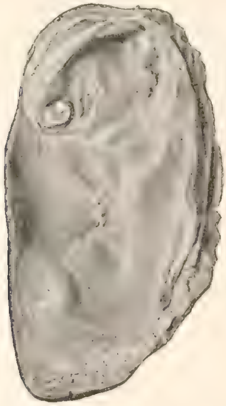

FIG. 3.—*Ostrea* (*Exogyra*), sp. Right valve. Natural size.

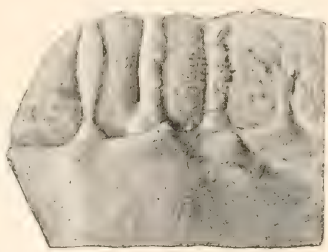

FIG. 4.—*Perna*, sp. Left valve. Internal cast of part near the umbo and of part of the ligamental area. Natural size.

OSTREA (EXOGYRA), sp.

Text-figure 3.

There are two right valves which resemble *O.* (*Exogyra*) *Langloisi*, Coquand, from the Senonian (Santonian) of Algeria and Tunis.†

* Coquand, Monogr. du Genre Ostrea (1869), p. 35, pl. xiii., figs. 2–10. Stoliczka, Cret. Fauna S. India, vol. iii. (1871), p. 465, pl. xlii., figs. 2–4, pl. xliii., fig. 1, pl. xlv., figs. 7–12. Peron, Brachiopodes, etc., de la Tunisie (1893), p. 175. Wanner, Palæontographica, vol. xxx., pt. 2 (1902), p. 119, pl. xvii., figs. 10–12.

† Peron, *op. cit.*, p. 146, pl. xxiv., figs. 14, 19.

PECTEN (NEITHEA), sp.

An imperfect specimen which appears to be part of a left valve of *Neithea* is present in the collection.

PERNA, sp.

Text-figures 4–6.

There are twelve internal casts of a large sub-quadrate *Perna*. In some cases portions of the shell are preserved and show a prismatic structure similar to that seen in *P. Ricordeana*, d'Orb.

FIG. 5.—*Perna*, sp. Internal cast. Left valve and anterior view of both valves. The posterior and the ventral margins are imperfect. × $\frac{4}{5}$.

The largest specimen has a height of about 150 mm., and its hinge-line is about 85 mm. long. One example shows the cast of the ligament area and grooves. This species resembles *P. valida* (Stoliczka) * from the Ariyalúr Group (Senonian) of Southern India,

* Cret. Fauna S. India, vol. iii. (1871), p. 409, pl. xxii., fig. 1.

and also *P. cereviciana*, Pethö,* from the Senonian of Čereviič (Hungary). But more perfect specimens are needed before an exact determination can be made. The ligament grooves are less numerous and more widely separated than in *P. cereviciana*, but

Fig. 6.—*Perna*, sp. Internal cast. A considerable portion of the posterior part of the shell appears to be missing. $\times \frac{1}{5}$.

the flattened part of the shell extending ventrally from the umbo is similar in both species.

* Die Kreide- (Hypersenon-) Fauna d. Peterwardein. Gebirges (Palæontographica, lii., 1906), p. 234, pl. xvii.

NOTE ON THE LOCALITY.

These fossils were obtained by Mr. J. W. Woods, of East London, from Need's Camp, on the Buffalo River, twenty miles from the sea and at an altitude of about 1,200 * feet. Mr. Woods says the limestone is "exposed in two open workings about two miles apart, and the one about fifty feet higher than the other. In the lower the greatest thickness is six feet and seems to be composed entirely of the remains of small shells, echinids, cup-corals, and various spines. . . . In the upper quarry the limestone is mainly crystalline and hard, and seems to be a mass of shell of mussel type: a few 'shark's' teeth have been found in it. We had a section there of eight feet to examine, and how much more exists cannot be stated as the workings have not gone deeper.

"The areas where the deposits occur are completely enclosed by dolerite: they may be described as two level ten-acre lots surrounded by boulders; and were, I presume, old shore-basins or lagoons, walled in by the igneous dyke, where the molluscs lived and died, or into which they were gradually swept by the tide."

The interest of this fauna is very great because it occurs at a place more than half-way between the Pondoland Upper Cretaceous outcrops and the main area of the marine Lower Cretaceous in Uitenhage. No fossils from similarly situated beds have been described, though limestones like that from the top quarry at Need's Camp are known from the neighbourhood of Sand Flats at about 1,200 feet above sea-level.

A. W. Rogers.

* This is the figure given by Mr. Woods; it is probably too great by 100 feet, as in Gamble's list of heights the Need's Camp beacon is said, on the authority of Capt. W. Bailey, R.E., to be 1,144 feet above sea-level.

EXPLANATION OF PLATE I.

POLYZOA AND ECHINOIDEA FROM THE UPPER CRETACEOUS OF NEED'S CAMP, BUFFALO RIVER, CAPE COLONY.

1. *Filisparsa ramosa*, d'Orbigny. × 12. Obverse face of part of a zoarium, showing tendency of apertures to be arranged in V-shaped rows (p. 408).
2. *Filisparsa fragilis*, Marsson. × 12. Obverse face of part of a zoarium (p. 408).
3. *Diastopora compressa* (Goldfuss). × 12. A young zoarium, showing the first-formed zoœcia to be slightly emergent, while the more distal are immersed (p. 409).
4. *Idmonea virgula*, d'Orbigny. × 12. Obverse face of zoarium (p. 410).
5. *Crisina cenomana*, d'Orbigny. × 12. Obverse face of a specimen resembling d'Orbigny's figure of *Idmonea calypso*, showing strongly-marked zoœcial boundaries (p. 411).
6. *Crisina excavata* (d'Orbigny). × 12. Obverse face of part of a zoarium. In the proximal part the lateral series of apertures of each side are practically opposite, and so appear to form continuous bands across the zoarium. Distally is a front view of the right-hand series only, and those of the left-hand are seen in profile (p. 412).
7. *Crisina marginata* (d'Orbigny). × 12. Obverse face of part of a zoarium viewed rather from the right side, so that only the edges of the left-hand series of apertures appear; the alternate arrangement of the series of apertures is therefore not obvious in the figure (p. 412).
8. *Tervia dorsata* (von Hagenow). × 12. Obverse face of part of a zoarium (p. 413).
9. *Tervia gibbera*, Gregory. × 12. Obverse face of part of a zoarium viewed from the left-hand side. The end of a "dorsal process" appears at the top left-hand side of the figure, springing distally from the reverse face (p. 413).
10. *Entalophora virgula* (von Hagenow). × 12. Part of a zoarium (p. 414).
11. *Entalophora conjugata* (von Reuss). × 12. Part of a zoarium. Some of the apertures appear to be arranged in whorls or spirals; but these are only rows of three, and the series do not continue on the half of the branch not shown (p. 415).
12. *Entalophora echinata* (Römer). × 12. Part of a worn zoarium (p. 415).
13. *Spiropora verticillata* (Goldfuss). × 12. Part of a zoarium (p. 417).
14. *Entalophora madraporacea* (Goldfuss). × 12. Part of a worn zoarium (p. 416).

15–17. *Coptosoma capense*, sp. nov. Natural size. (p. 419).

T. A. Brock del. West, Newman collo.

Need's Camp Fossils.

3.—*The Invertebrate Fauna and Palæontological Relations of the Uitenhage Series.*—By F. L. Kitchin, M.A., Ph.D., F.G.S.

CONTENTS.

I.—INTRODUCTION.

The marine invertebrate fossils collected in 1900 by Mr. A. W. Rogers and Mr. E. H. L. Schwarz from the Uitenhage Series, and forwarded to me by Mr. Rogers on behalf of the Geological Commission, were found at localities near Uitenhage and below this on the Zwartkop's River, and in the valley of the Sunday's River near and below Dunbrodie. Further materials have been sent from the South

African Museum, principally comprising specimens presented by R. Rubidge and C. A. Fairbridge, and I have also received a small but interesting collection of Mollusca found by Miss M. Wilman in the Uitenhage strata exposed in the Coega neighbourhood. In addition to the marine fossils obtained by Messrs. Rogers and Schwarz, some shells of the genus *Unio* were collected in the Bezuidenhout's Valley below Blue Cliff.

In 1905 Mr. Rogers devoted some time to a further examination of the Uitenhage beds in the valleys of the Sunday's River and Coega River, and made an additional collection of fossils ; he also obtained a few specimens from an exposure of Uitenhage beds at Brentford, in Knysna.* The results of an examination of these supplementary materials have been incorporated in the following account, which has been withheld from publication for this purpose.

In view of the extensive manner in which the fauna of the Uitenhage Series has already been made known, particularly by the writings of Krauss, Sharpe, Tate, and Neumayr, it is not surprising to find that among the specimens collected during the preliminary survey in the Uitenhage and Port Elizabeth Divisions comparatively few new forms are represented. It could be gathered, however, from the published account of this survey,† that more prolonged search would in all probability add materially to an already lengthy list, and, in fact, the specimens obtained by Mr. Rogers in 1905 well bear this out, for they include a larger proportion of new species than that shown by the collections made in 1900.‡

In the following pages I have discussed the present state of our knowledge regarding the palæontological relations of the fauna, so far as concerns the invertebrate remains, and then proceeded to the description of the new materials submitted to me, while adding critical remarks and supplementary descriptions relative to some of the forms already known. Opportunity is also afforded by the present study to describe and figure two Uitenhage ammonites which are represented by specimens preserved in the collection of the Geological Society of London, though not included in the material sent to me from Cape Town; it is useful to have some account of these, both for the sake of comparison with other members of the

* A new locality for Uitenhage marine fossils; see Schwarz (2), pp. 50, 74. [The numbers in parentheses after the names of authors, in this and subsequent references to literature, correspond with the titles of works bearing the same number under the names of those authors in the bibliographical list with which this mèmoir concludes.]

† Rogers and Schwarz (1).

‡ For an account of the survey of 1905, see Rogers (2).

same genus which occur in the Uitenhage beds and in order to broaden the foundation for future work.

From statements made in the Reports mentioned above, it seems that in our present state of knowledge no satisfactory subdivision of the Uitenhage beds is possible, and that the members of the series are so variably developed that no consistent nomenclature is to be hoped for until detailed mapping can be carried out. Of the subdivisions hitherto employed, the uppermost member of the series, the Sunday's River or Marine Beds, has yielded the majority of the Mollusca which are discussed in this paper. The underlying "Wood Bed" series has also furnished a few species of marine molluscs in addition to *Unio* and remains of fossil plants. The so-called Enon Beds represent the lowest division of the formation in this district. Messrs. Rogers and Schwarz, while indicating the local significance of the adopted subdivisions, draw attention to the limited value of this nomenclature, and mention facts which clearly show the contemporaneous variation of facies in the series. Thus, to the north of Uitenhage, the Marine Beds appear to be synchronous with part of the local conglomerate of "Enon" character, and it is pointed out that at Plettenberg's Bay also, the Sunday's River Beds are partly replaced by conglomerate resembling that of the Enon Beds, but here yielding *Trigonia conocardiiformis*, one of the most characteristic fossils of the Marine Beds.*

The question of the age to be assigned to the Uitenhage Series, as is well known, has called forth strikingly different opinions from various authors. It was suggested by Stow in 1871 † that the want of unanimity among the earlier writers might have been due to careless collecting and the mingling of specimens obtained from different horizons. This author therefore made his own collections with due regard to the localities and the individual bands in which he found the fossils to occur, and he attempted a correlation of the fossiliferous beds exposed in sections at various places on the Sunday's and Zwartkop's Rivers. It appears highly probable, however, from the palæontological evidence alone, that no very considerable extent of time is represented by the whole of the beds which yield marine fossils, and there is nothing to show that the different opinions respecting the age of the series have been arrived at in consequence of any radical change in the character of the fauna itself in its distribution through the strata. That any such marked change can be

* Schwarz (1), pp. 53, 61; Rogers and Schwarz (1), p. 5; Rogers (1), pp. 282–296. See also Rogers (2), pp. 13, 15.

† Stow (1).

traced is not evident from the table of sections given by Stow.* There are, no doubt, minor differences, and local distribution according to facies in the successive fossiliferous bands, which may be more clearly revealed when the district comes to be mapped in detail; but there is certainly nothing so far-reaching in this respect as to have formed grounds for the differences of view expressed, for instance, by Tate, who ascribed an Oolitic age to the fauna, and Neumayr, who referred these beds to the Neocomian.†

The divergent conclusions arrived at by the earlier authors appear rather to have resulted from the different interpretations put upon the same peculiar association of forms when viewed in comparison with the limited standards of European type. The principal difficulty seems to have lain in the fact that none of the fossils could be correctly identified with those of formations studied in other regions, and the facies of the fauna, taken as a whole, did not seem to show such agreement with that of any known assemblage as to give it the decided stamp which might serve to put the question of age beyond dispute. This matter has been so frequently dealt with, and its bearings are so well known, that it may seem superfluous to dwell upon it here at any length; but it may be useful to recapitulate briefly the successive opinions expressed, and in some cases the grounds upon which they were based, before proceeding to the more thorough comparison of the fauna with its extra-European equivalents which recent knowledge has rendered possible.

I take this opportunity of expressing my indebtedness to Mr. A. W. Rogers for the helpful manner in which he has furnished me with information relating to the collections; to Dr. A. Smith Woodward, Mr. G. C. Crick, and Mr. R. B. Newton for facilitating reference to literature and specimens in the British Museum (Natural History); and to Mr. W. Rupert Jones for his ready assistance during my repeated examinations of the extensive collection of Uitenhage fossils in the museum of the Geological Society of London. My best thanks are also due to Prof. J. W. Gregory for examining a specimen of *Thamnastræa* submitted to him, and to Mr. C. D. Sherborn for assistance in a few matters relating to bibliography; to Mr. G. W. Lamplugh, Mr. H. A. Allen, and Mr. H. Woods, I am indebted for several useful suggestions.

* Stow (1), fig. 3. See further remarks on this subject at the end of Section II. of the present paper.

† In this connection see Neumayr's remarks on Stow's work; Holub and Neumayr (1), p. 270, footnote 6

II.—THE AGE OF THE FAUNA.

(*a*) *Summary of Previous Work.*—In 1837, Hausmann recorded the occurrence of some shells obtained by Hertzog from strata in the Sunday's River district, to which he ascribed a Lower Cretaceous age. These included a *Hamites*, which was compared with *H. intermedius* J. Sow. and *H. funatus* Brongn., and a *Trigonia* which was thought to resemble *T. dædalea* Park.* Goldfuss afterwards described and figured two of Hausmann's shells under the names *Lyrodon herzogi* and *Cytherea herzogi*, and also considered them to be of Greensand age.†

The examination of a small collection of lamellibranchs obtained by F. Krauss in 1839 from strata exposed on the Zwartkop's River, led that author to the conclusion that they indicated a Lower Greensand horizon,‡ and in another paper Krauss furnished excellent descriptions and figures of these shells, maintaining a similar view concerning their age.§

In 1851 a collection of fossil plants and molluscs, obtained by R. Rubidge on the Sunday's River, was exhibited before the British Association at Ipswich by Colonel Portlock, who remarked that the shells were apparently of Jurassic age, while Dr. Harvey's examination of the plant remains was thought to corroborate this view.||

In his well-known paper published in 1856, A. G. Bain¶ referred the Uitenhage fossils with doubt to the Lias, basing this opinion upon the prevalence of a supposed Liassic form, "*Gryphæa incurva.*" The shell mistaken for this, however, was *Exogyra imbricata*, previously described by Krauss, which, as we shall see, bears only a superficial resemblance to the *Gryphæa* mentioned, and is in reality closely comparable with certain Lower Cretaceous forms of *Exogyra*. Appended to Bain's paper were D. Sharpe's descriptions of the Secondary fossils collected by Atherstone and Bain from localities on the Sunday's and Zwartkop's Rivers. The forms described, principally Mullusca, led Sharpe to the conclusion that they most nearly resembled European species of the Middle and Lower Oolites; he compared his *Ammonites atherstoni* with *A. macrocephalus* and *A. herveyi*, while believing *Ammonites baini* to be related to *A. humphresianus* and other Lower Oolitic forms.

* Hausmann (1), p. 1457.

† Goldfuss (1), Band II., p. 202, pl. 137, fig. 5 (1837); p. 239, pl. 149, fig. 10 (1840).

‡ Krauss (1), pp. 129, 130.

§ Krauss (2).

|| Portlock (1).

¶ Bain (1).

In 1867, a paper by Ralph Tate,* in which many new forms were described and figured, added largely to our knowledge of the Uitenhage fossils, and this author was led to some remarkable conclusions from his study of the fauna. He believed the assemblage to indicate a Jurassic age, and stated that he thought it to represent the fauna of the Oolitic rocks of Europe, and to approximate to that of the Great Oolite. It seems clear that in instituting this comparison, he made use of some molluscan types little adapted to serve the purposes of a critical correlation, and he was at the same time misled by several quite erroneous identifications. He also misunderstood the affinities of the cephalopods and the significance of certain *Trigoniæ* which alone might have been expected to form obstacles to his conclusions. It is here scarcely necessary to do more than refer to the curious generalisation arrived at by Tate concerning the relation of these supposed Jurassic deposits to the Jurassic strata of Europe, namely, that the "Oolites" of South Africa are the representatives of the whole of the Jurassic rocks of Europe with the exception of the Upper Oolites, and illustrate an intermingling of palæontological types which are analogous to, or identical with, those distributed in successive zones in Europe.

In his monograph on the Cretaceous lamellibranchs of Southern India, Stoliczka† made some reference to Uitenhage forms. He evidently believed Tate's *Crassatella complicata* to belong to the genus *Ptychomya*, and he ascribed *Astarte herzogi* Krauss to Speyer's genus *Grotriania*. He further expressed the opinion that Krauss's *Astarte bronni* might belong to the Cretaceous genus *Remondia* Gabb, and thought that in addition to these and *Trigonia ventricosa*, several other Uitenhage shells show a Cretaceous rather than a Jurassic aspect; attention was drawn to the great similarity between *Trigonia ventricosa* (Krauss) and the Cretaceous *T. tuberculifera* Stol., from Southern India. While we shall see that Stoliczka rightly recognised some of the Uitenhage forms to exhibit Cretaceous affinities, he was in error in ascribing *Astarte herzogi* to the genus *Grotriania*, and, as afterwards pointed out by Neumayr, wrongly supposed *Astarte bronni* to belong to the genus *Remondia*. *A. bronni* is so distinctly characterised that Neumayr proposed for it the new generic name *Seebachia*—a fact which appears to have been overlooked by Stanton, who in 1897 still tentatively included it in the genus *Remondia*.‡

One of Tate's Uitenhage species, the so-called *Crassatella com-*

* Tate (1). † Stoliczka (2), pp. 286, 294, 315 (1871).

‡ Stanton (1).

plicata, was later also recognised by Dames to be a representative of the genus *Ptychomya*,* and this seemed to point to a later age for the strata from which it was obtained than that assigned by Tate. Dames was further led to the belief in the Neocomian age of the Uitenhage beds by a fragment of an ammonite (sent by Krauss to L. von Buch) which he thought to be identical with *Ammonites astierianus* d'Orb.

In the concluding chapter of his monograph on the British Fossil *Trigoniæ*, Lycett † referred briefly to the *Trigoniæ* of the Uitenhage Formation, and expressed his opinion that some of the most characteristic of these point decisively to a Cretaceous age; he also showed that the alleged occurrence of *T. goldfussi*, which Tate had used as evidence for a Jurassic age, rested on an erroneous determination.

The whole question of the age of this fauna was afterwards well handled by Neumayr,‡ who subjected Tate's work to some criticism. Neumayr set on one side many molluscan types as of little significance in a comparative study, and concluded that a costate *Trigonia* (*T. tatei* Neum.) alone exhibited a marked Jurassic character. On the other hand, he considered a number of forms to represent essentially Cretaceous types. Such were *Holcostephanus atherstoni* (Sharpe); *Holcostephanus baini* (Sharpe); *Crioceras spinosissimum* (Hausm.) Neumayr; *Trigonia ventricosa* (Krauss); *Trigonia conocardiiformis* (Krauss); *Ptychomya complicata* (Tate)§; and *Exogyra imbricata* Krauss. He suggested that Tate's *Ammonites subanceps*, which was thought by Tate to resemble the Jurassic *A. anceps* Rein., might really represent the young of *Crioceras spinosissimum*. It was admitted by Neumayr that *Belemnites africanus* Tate, which Tate placed in the group Canaliculati and considered to afford strong evidence for an Oolitic age, bears a strong resemblance to the Jurassic forms *B. canaliculatus* Schloth. and *B. magnificus* d'Orb.; but at the same time he drew attention to the existence of a belemnite in the Lower Cretaceous of North Germany which seemed to share some of the characteristics of *B. africanus*. In a later paper, written after an examination of Tate's original specimen in the collection of the Geological Society, Neumayr || definitely separated *B. africanus* from the Canaliculati, and included it in his group of the Absoluti, which, as he remarked, extend in their occurrence up to the Aptian; hence the conclusive nature of the

* Dames (1).

† Lycett (3), p. 230 (1879).

‡ Holub and Neumayr (1).

§ Misquoted "*implicata*" by Neumayr.

|| Neumayr (4).

evidence for age furnished by the occurrence of *B. africanus* in the Uitenhage beds was no longer to be recognised.* Neumayr's argument for the Lower Cretaceous age of this fauna appears indeed to be overwhelmingly strong, particularly in the evidence of the Cephalopoda, all of which he found to possess near allies in European Neocomian forms. Regarding the two species of *Holcostephanus*, Neumayr pointed out that their resemblance to the Jurassic types with which they had previously been brought into comparison was only of a superficial character, depending alone on a certain outward similarity of habit.

Pavlow † has since confirmed this view, after studying South African specimens, and has placed *Holcostephanus atherstoni* and *H. baini* in his generic or sub-generic division *Astieria*, which comprises numerous Neocomian types; he even goes so far as to identify *Holcostephanus atherstoni* with *H. psilostomus* Neum. and Uhlig, ‡ from the Hilsthon of North Germany, and to the same form he ascribes a shell from the Neocomian of Speeton.

In view of the fact that the plant remains found in the Uitenhage beds had previously been thought to point rather to an Oolitic than a Cretaceous age, and having regard to the division of opinion concerning the affinities of the invertebrate fauna, Messrs. Rogers and Schwarz, in 1901, were led to adopt the provisional conclusion that the Uitenhage Series may be assigned to the Upper Jurassic.§ In stating this, they mention that the fauna and flora have been considered to resemble in some degree those of the Jurassic series in Cutch. It is well known that the resemblance between certain lamellibranchs of the Uitenhage beds and those of the Oomia Group in Cutch has been frequently remarked upon, but it can no longer be maintained that the marine Oomia strata are in reality of Jurassic age, at least so far as concerns the *Trigonia*-beds; but this is a point to which we may presently return, and one which we may consider in greater detail.

In more recent works Mr. Rogers || gives us a comprehensive account of the Uitenhage Series, and now considers these beds to represent a portion of the Cretaceous system. The same view is adopted by Drs. Hatch and Corstorphine in their "Geology of South Africa" (1905). With reference to the flora, Prof. A. C.

* See also Neumayr (5).

† Pavlow and Lamplugh (1), pp. 492–497 (134–139 in authors' copy).

‡ Neumayr and Uhlig (1), p. 149, pl. xxxii., fig. 2.

§ Rogers and Schwarz (1), p. 17.

|| Rogers (1), pp. 281–318; Rogers (2), pp. 15–33, 45.

Seward, in his memoir on the subject,* has shown that the Uitenhage plants "include types in part characteristic of Wealden and in part indicative of Jurassic floras"; but he believes that the balance of evidence derived from the plants is in favour of a Wealden age.

We thus see that recent authoritative opinions have lent strong confirmation to the views of the earliest writers who made a study of this fauna. Other works in which less critical reference has been made to the age of the Uitenhage Series may now be briefly noticed.

In 1857, W. G. Atherstone suggested the partly Jurassic and partly Cretaceous age of the Uitenhage beds,† but Andrew Wyley, in 1859, placed the Enon Beds so low as the New Red Sandstone, and correlated the Sunday's River Beds with the Jurassic (Oolites).‡

Feistmantel§ evidently shared Tate's view of an Oolitic age when he tried to show affinities between certain Mollusca from the Uitenhage beds and others from the Oomia Group in Cutch in order to prove the Lower Oolitic age of the Oomia fauna and bring about harmony between the evidence for age furnished by the plants and animals from those beds. In a correlation of the Indian and African Mesozoic formations the same author also tabulated the Uitenhage Series as Jurassic.|| G. W. Stow divided the formation into a "Lower Jurassic" and an "Upper Jurassic" series.¶ In 1878 W. T. Blanford, basing his view upon a study of Tate's and Stow's papers, concluded that the beds containing *Hamites* yielded too large a number of Middle Jurassic forms for reference to the Neocomian; but he believed them to represent a very high Jurassic horizon, while pointing out that *Trigonia ventricosa* and *T. vau* were still higher.**

In 1880 Griesbach classed the Uitenhage beds as Jurassic,†† while the same view was adopted by T. Rupert Jones in 1884 ‡‡ and by Moulle in the following year.§§ Even so recently as 1897, Futterer has accepted Sharpe's and Tate's conclusions.|||| On the other hand, Gürich,¶¶ Schenck,*** and Molengraaff ††† have referred these beds

* Seward (1), p. 46.

† Atherstone (1), pp. 584, 588.

‡ Wyley (1). [I have not seen Wyley's Report, but his correlation is set forth in Tate (1), p. 172, and Corstorphine (1), Appendix.]

§ Feistmantel (1).

|| Feistmantel (4), pp. 54, 59, 84.

¶ Stow (1).

** W. T. Blanford (1), p. 118.

†† Griesbach (1), pp. 90, 93.

‡‡ Jones (1); Jones (2), p. 737.

§§ Moulle (1), p. 216.

|||| Futterer (1), p. 625.

¶¶ Gürich (1).

*** Schenck (1), p. 231.

††† Molengraaff (1). [I have not been able to see this work, but quote the statement and reference on the authority of Newton (2), p. 146.]

to the Lower Cretaceous; but in a more recently published tabular correlation of the geological formations of the Transvaal and Cape Colony, Molengraaff has ascribed them with a note of interrogation to the Middle Jurassic.* In 1896 R. B. Newton published a useful summary of previous work on the Cretaceous conchology of South Africa,† and furnished a complete list of the known Mollusca from the Uitenhage beds, which he classed as Neocomian. In their text-books de Lapparent ‡ and Kayser § have followed Holub and Neumayr in assigning a Neocomian age. Passarge, in his work on the Kalahari,|| has tabulated the Uitenhage Series with the Upper Jurassic and Lower Cretaceous. Lemoine believes it to be of Lower Cretaceous age.¶

(*b*) *Additional Evidence for Age.*—We see from the foregoing that a comparison of the Uitenhage Mollusca with European forms seems to point definitely to a Lower Cretaceous age, for it will be conceded that the evidence of the Cephalopoda must be allowed to carry the greatest weight in influencing a decision. The representatives of *Holcostephanus* (sensu stricto), *Hamites* and *Crioceras* already recorded, supply in themselves sufficiently striking evidence, and notable additions to these are other forms of *Holcostephanus*, as well as representatives of *Acanthodiscus* and *Bochianites* included in the collections submitted for examination and described in these pages. Two other species of *Holcostephanus* (sensu stricto), hitherto undescribed, are represented in the collection of the Geological Society of London. One of these is apparently allied to *H. atherstoni* (Sharpe), but has greater lateral compression as well as other distinctive characters. It closely resembles *H. psilostomus* Neum. and Uhlig, of the European Neocomian, and is the "compressed variety" of *H. atherstoni* mentioned by Pavlow,** who aptly suggested close relationship to a shell from the Neocomian of Spain, figured by Nicklès as *Holcostephanus hispanicus*. The significance of such an assemblage of Cephalopoda in the Uitenhage beds cannot be mistaken, quite apart from the bivalve forms to be mentioned below and a representative of the Crustacean genus *Meyeria*. In Europe the known species of *Holcostephanus* (sensu stricto) are almost wholly, if not entirely, confined to strata of Upper Valanginian and Lower Hauterivian age.

In his paper on the Uitenhage fauna R. Tate †† gave a tabular list

* Molengraaff (2), p. 119.
† Newton (2).
‡ de Lapparent (1), p. 1267.
§ Kayser (1), p. 444.
|| Passarge (1), p. 82; see also p. 597.
¶ Lemoine (1), pp. 383, 389.
** Pavlow and Lamplugh (1), pp. 492, 496, (134 and 138 of authors' copy).
†† Tate (1), p. 166.

of some of the more important fossils, together with their supposed extra-African allies and analogues, which, with one exception, were thought to be Jurassic. An examination of this list shows, however, that a different construction must now be put upon the comparisons, as may be demonstrated by the mention of a few examples. In addition to *Holcostephanus atherstoni* and *H. baini*, which were erroneously thought to be allied to well-known Oolitic forms, there is Tate's *Ammonites subanceps*, a single specimen, regarding which that author wrote: "It is doubtful whether this be not a mere variety of *A. anceps* Reinecke, of the Middle Oolites." As already mentioned, Neumayr thought that it might represent a stage in the individual growth of *Crioceras spinosissimum*, which he supposed to have had the whorls in contact at such an immature period. This may be a correct view, but it seems equally probable that we are dealing with an immature example of some species of *Hoplites* (sensu lato). Tate's specimen, of which his published figures convey a very imperfect and even misleading impression, shows great similarity to certain forms which have been ascribed by Sayn to *Hoplites arnoldi* (Pict. and Camp.), and by Toucas to *H. botellæ* Kilian. These were thought by Pavlow to have been wrongly identified, and are united by him under the name *Hoplites heteroptychus*, which has more recently been included by Uhlig in his narrower generic group *Solgeria*. A somewhat similar form has been described and figured by Bogoslowsky under the name *Hoplites* aff. *arnoldi* Pict., and this is said to occur with *Belemnites lateralis* Phill. above the "Rjasan-Horizont" in Russia (Mostja River).* *Hoplites subanceps* is more closely and less coarsely ornamented than this, but there are points of agreement in the type of sculpture. Further observations on "*Ammonites*" *subanceps* are given in the remarks which follow the description of a specimen ascribed to *Acanthodiscus sp.*, in the following pages.

Ostrea jonesiana Tate was compared by Tate with *O. costata* Sow. from the Oolites; but it is in reality a true *Exogyra* quite comparable with shells of the type of *E. subplicata* Roem.,† from the Hilsconglomerat of North Germany.

Pecten projectus was compared with *P. lens* Sow., but such a comparison must have little value when we remember that species of *Pecten* with similar broad characteristics recur at various horizons and are not confined to the Jurassic rocks. *Pecten projectus*, in

* Bogoslowsky (1), pp. 112, 138; Taf. vi., fig. 7.

† F. A. Roemer (1), Nachtrag, p. 25, pl. xviii., fig. 17; F. A. Roemer (2), p. 47 (1840).

fact, compares more satisfactorily with some of the Cretaceous forms.

The comparison of *Pecten rubidgeanus* with *P. subspinosus* Schloth. cannot be pronounced at all fortunate, while we shall find that *Lima obliquissima* shows a closer agreement of characters with Cretaceous and later forms than with the European Jurassic shells cited by Tate.

Placunopsis subjurensis Tate, which was compared with *P. jurensis* Roem., may perhaps be an *Anomia*, and in some respects closely resembles *A. pseudoradiata* d'Orb.,* from the Aptian. *Placunopsis imbricata* Tate is compared in the table with *P. substriata* Lyc., from the Oolites. *P. semistriata* (Bean) was probably the English shell with which it was intended to institute comparison, since this name alone is mentioned in Tate's description on page 154 of his paper. *P. imbricata*, however, is without radial ornamentation, but is characterised by well-spaced concentric ridges which recall the similar ornamentation of *Anomia neocomiensis* d'Orb., † though occurring in less emphasised form. The illustration of *P. imbricata* gives a very poor idea of the shell, but an examination of the specimen dispels the notion of a close comparison with known Jurassic forms.

Trigonia cassiope Tate is not to be united with any known Jurassic costate *Trigonia*, and was accordingly renamed *T. tatei* by Neumayr. It is well distinguished by the elongated escutcheon, the very delicate marginal carina, and the fine character of the ornamentation on the area and escutcheon. *Trigonia goldfussi* Tate is an immature shell, and in all probability illustrates the youthful stage of one of the large and robustly ornamented Pseudo-quadratæ which form such a striking feature in the Uitenhage fauna. It certainly does not represent either *Trigonia goldfussi* Agassiz or *T. painei* Lyc. (= *T. goldfussi* Morr. and Lyc.), with which it was identified. Tate himself, on page 159 of his paper, said: "Hereafter, however, it may be found to be the young of a distinct species." It is therefore the more regrettable that the error of quoting this European Jurassic shell from the Uitenhage beds should have continued to be perpetrated. Stow ‡ repeatedly used the name "*T. goldfussi*" in his paper, but I have been unable to ascertain to which of the *Trigoniæ* he referred.

No importance can be attached to the comparison of such types as

* d'Orbigny (4), p. 84; Woods (3), vol. i., p. 27, pl. v., figs. 1–3 (1899).

† d'Orbigny (3), p. 754, pl. 489, figs. 1–3 (1848).

‡ Stow (1), pp. 497–514.

Pinna atherstoni Sharpe and *P. sharpei* Tate with Jurassic forms, for it is evident that these representatives of the genus lack any strong distinctive characters which alone would render them of value in an estimate of geological age.

Mytilus baini Sharpe was compared with *M. sowerbianus* d'Orb., from the Oolites of Europe. It is a *Modiola* which certainly has characters of form and ornamentation closely similar to those which distinguished *M. sowerbiana* (d'Orb.) and *M. perplicata* (Etallon); but this type of *Modiola* is by no means confined to Jurassic rocks, having also a widely distributed representative in the Cretaceous *M. flagellifera* (Forbes), to mention a well-known example.

Pholadomya dominicalis Sharpe was thought to resemble Liassic and Oxfordian forms, but it may equally well be brought into comparison with Lower Cretaceous representatives; for example, the European Aptian shell ascribed, rightly or wrongly, to *P. pedernalis* Roem.*

Astarte pinchiniana Tate was brought into comparison with *A. pumila* Goldf. and *A. excentrica* Morr. and Lyc., from the Great Oolite of Europe. The African shell differs in important respects from these, and, as will be pointed out below, it probably belongs to the sub-generic group *Eriphyla* and is certainly most closely comparable with Cretaceous forms.

Berenicea antipodum Tate was believed by Tate to be related to *B. striata* Haime, from the Lower Lias of France, but has been regarded by Prof. J. W. Gregory † as a close ally of the Cretaceous *B. gracilis* (Milne Edwards).

Two Uitenhage *Serpulæ* were identified by Tate with *S. filaria* Goldf. and *S. plicatilis* Münst., from the Inferior Oolite of Europe. The specimens ascribed to *S. plicatilis* represent an adherent form sharply carinated on the back, with a weaker carinal angle on either side and a circular aperture, but the true *S. plicatilis* Goldf. has only a single central, longitudinal keel. *S. quinquangularis* Goldf. ‡ (Upper Jurassic) stands much closer in its characters, and a *Serpula* scarcely distinguishable from this occurs in the Lower Cretaceous of Europe, and may be found named *S. quinquangularis* in some collections. *S. filaria* Goldf. is a solitary, wholly adherent form, commencing with a coiled stage. So far as can be seen from the imperfect African specimen named *S. filaria* by Tate, this is a clustering form consisting of crowded, narrow cylindrical tubes, and

* Pictet and Renevier (1), p. 60, pl. vi., fig. 7, 1855; Moesch (1), p. 93, pl. xxxiii., fig. 2.

† Gregory (1), p. 112.

‡ Goldfuss (1), Band i., p. 230, pl. 68, fig. 8 (1831).

it is not distinguishable from the English Lower Cretaceous *Serpulæ* that have been variously referred to *Serpula filiformis* J. de C. Sow, and *S. plexus* J. de C. Sow. We thus see that in the case of the two *Trigoniæ* and the two *Serpulæ* which Tate identified with European Jurassic types, the determinations were so far erroneous that they are now bereft of the significance which was attached to them as evidence for the age of the fauna.

We may further examine the evidence for age afforded by some of the more conspicuous bivalves, and firstly I may briefly refer to the representatives of the genus *Trigonia*, which in themselves lend such a characteristic aspect to the fauna. Although the testimony of these is perhaps not quite so conclusive as Lycett supposed, still, the balance of evidence furnished by members of this genus may be safely relied upon to give a fair indication of age, even when considered apart from associated forms, and the material we are dealing with in the present instance is fortunately of an exceptionally favourable character. In the first place there is *Trigonia ventricosa*, *T. kraussi*, and *T. rogersi*, all possessing the characters of the section Scabræ—a division which, so far as we know, is elsewhere only represented in rocks of Cretaceous age. These might be considered to be balanced by the occurrence of *T. tatei*, a typical member of the section Costatæ, but although this division of the *Trigoniæ* has its maximum development in the Oolitic rocks, it is also represented in strata of Lower Cretaceous and even later age.

Trigonia peninsularis Coquand,* from the Aptian of Spain, certainly shows characters of degeneration not shared by *T. tatei*, but the Oomia strata of Cutch have yielded two normal representatives of the Costatæ, which, together with some degenerate derivatives of this section, are accompanied by *Trigoniæ* which exhibit a decidedly Cretaceous aspect. Another unmodified costate form, *T. angustecostata* Behr. † occurs in the Argentine Republic in strata which are regarded by Behrendsen as Upper Cretaceous, while a typical member of this section has been described by E. Ascher from the Grodischter beds (Hauterivian) of Silesia. ‡

Trigonia herzogi (Goldf.), another very characteristic Uitenhage form, was believed by Lycett to belong to the Quadratæ, which, so far as known, are exclusively Cretaceous. Steinmann,§ however, pointed out that *Trigonia herzogi* differs in several important par-

* Coquand (1), p. 129, pl. xxiii., fig. 3.

† Behrendsen (1), p. 6, pl. 3, fig. 7.

‡ Ascher (1), p. 159 [25], p. xiii. [ii.], fig. 10.

§ Steinmann (2).

ticulars from all known Quadratæ, and found that the special features which distinguish this Uitenhage shell from the Jurassic Clavellatæ on the one hand and the Cretaceous Quadratæ on the other, are shared by *Trigonia transitoria* Steinm. from Lower Cretaceous rocks in Bolivia, Chili, and the Argentine Republic. He therefore suggested a new group-name, the Pseudo-quadratæ, to comprise these two *Trigoniæ*, which were the only examples known to exhibit these peculiar distinguishing characters. *Trigonia neuquensis* Burckhardt,* which occurs with *T. transitoria* in Neocomian rocks at Las Lajas on the Rio Agrio (Argentine), falls under the same heading, while *T. mamillata* † from the Oomia strata in Cutch must also be referred to this group. Still another form, described in these pages (*T. holubi*), is clearly referable to the same category. Although the five members of the Pseudo-quadratæ known to us are all similarly differentiated from the typical Clavellatæ, it is not certain that they are all so closely related to one another as might at first sight appear to be the case; some, at least, may possibly have been independently evolved from clavellate ancestors.‡ Nor is it by any means certain that they bear any close and direct relationship to the true Quadratæ, and though definite indications on this point fail us, it is quite probable that the Quadratæ and Pseudo-quadratæ represent parallel and independent groups of derivatives arising from Jurassic Clavellatæ. It is therefore evident that the *Trigoniæ* of the group Pseudo-quadratæ cannot yet be considered in themselves to furnish quite such reliable guidance to geological age as the true Quadratæ, but at the same time their general aspect, by comparison with the Quadratæ, strongly suggests a Cretaceous age, while the known South American representatives must, in fact, be regarded as Neocomian. Some of the most important features wherein the Quadratæ differ from the Clavellatæ are also exemplified in the Pseudo-quadratæ. Lycett laid great emphasis on the presence or absence of sculpture on the escutcheon in distinguishing between the Jurassic Clavellatæ on the one hand, and the Cretaceous Clavellatæ and Quadratæ on the other, and in regard to this feature all the Pseudo-quadratæ agree with the Quadratæ in having coarsely nodose ornamentation on the escutcheon. Further remarks on the points of agreement between these groups are appended to the description of *Trigonia holubi*.

Trigonia conocardiiformis (Krauss) was thought by Lycett to fall

* Burckhardt (2), p. 74, Taf. xiv., figs. 4–6.

† Kitchin (1), p. 100, pl. ix., figs. 8, 9; pl. x., figs. 1–3.

‡ Remarks on this subject will be found to follow the description and the discussion of the relationships of *Trigonia holubi*, in these pages.

within the section Scabræ, but a near relationship to members of this division is scarcely to be inferred from the adult characters displayed by this peculiar form, while a study of the young shell does not plainly reveal its affinities. A general comparison, however, shows that this *Trigonia* differs from the Jurassic Clavellatæ in a manner somewhat analogous to that which distinguishes the Scabræ, and a very closely similar and probably intimately related form occurs in the Neocomian of the Argentine Republic.

On the whole, so far as this *Trigonia*-assemblage is comparable with European forms, it must certainly be considered to display a Cretaceous rather than a Jurassic character, though when regarded collectively, it is without counterpart in the European area. The significance of other *Trigoniæ* included in this fauna will be discussed presently.

Still further indications of geological age are to be derived from a comparison of the Uitenhage lamellibranchs with European types. One of the shells submitted to me, which proves to be identical with a form previously described by Sharpe, who did not recognise its true generic position, is an example of the well-characterised genus *Thetironia*, which in Europe is widely distributed in Lower Cretaceous and higher strata, though it has not been recorded from rocks of an earlier age. A second species of *Thetironia* is also included in the collection. *Solecurtus* is another genus not known to occur in rocks older than Cretaceous, and a representative of this must now be added to the list of Uitenhage molluscs. The specimens sent to me for examination also include examples of *Pecten* which can only be identified with the Cretaceous *P. orbicularis* J. Sow. and *P. cottaldinus* d'Orb., while a third form may be most aptly brought into comparison with *P. subacutus* Lam. A representative of the Cretaceous genus *Anthonya* must also be recorded in this connection.

Gervillia dentata Krauss, though belonging to the group of *G. aviculoides*,* typically represented in Jurassic rocks (*G. deecki* Frech; *G. aviculoides* Sow.), has a close counterpart in *G. anceps* Desh. and *G. sublanceolata* d'Orb., in the Lower Cretaceous of Europe. A form closely similar, and perhaps identical, occurs also in the Neocomian of German East Africa. The long lateral tooth which Krauss thought to be so highly distinctive of *G. dentata* as almost to justify the establishment of a new genus, is a normal feature of the group, and is well developed in *G. anceps*.† Another common

* Frech (1). † Frech (1), pp. 612, 613.

and characteristic Uitenhage shell is *Exogyra imbricata* Krauss, and this belongs to a general type well exemplified in the Lower Cretaceous strata of Europe and South America. *Lima neglecta* Tate, belongs to the sub-generic division *Mantellum*, and most closely resembles forms which occur in the Lower Cretaceous of Europe. Reference has already been made to *Ptychomya complicata* (Tate), which is a typical representative of a genus widely distributed in the Lower Cretaceous rocks, where it first makes its appearance.

It is abundantly evident, then, that many of the most important and distinctive molluscan forms, amongst those with which we are dealing, give similar indications of geological horizon. There can be no doubt, indeed, that the marine Uitenhage fauna is of Neocomian age, though it is perhaps not possible to arrive at a very precise and positive estimate of equivalence with the divisions of the Neocomian in Europe, owing to the want of close coincidence in the faunas as developed in such widely separated regions. But *Holcostephanus atherstoni* (Sharpe) and *H. wilmanæ* sp. nov., if not actually represented in Europe, have very close allies there in the Valanginian and Hauterivian, and the Uitenhage Marine Beds may, in my opinion, be certainly correlated with these divisions. Further, it seems to me highly probable that the Marine Beds represent not more than the strata at the top of the Valanginian and the base of the Hauterivian.

The possibility that the lowest marine strata may be of greater age than Neocomian is not only most remote, but is contradicted by the palæontological evidence, so far as this goes. Fossiliferous strata, yielding a marine molluscan fauna characterised by the prevalence of Gasteropoda and the remains of oysters, occur at Dunbrodie (Sunday's River) associated with plant-bearing beds, and are in the lower part of the Uitenhage Series ; according to Messrs. Rogers and Schwarz they may be classed with the so-called "Wood Bed" series. Amongst the fossils collected here are *Actæonina atherstoni* (Sharpe), *Cyprina rugulosa* Sharpe, and a *Pecten* which I have identified as *Pecten cottaldinus* d'Orb. While *Actæonina atherstoni* is found also in the highest part of the Marine Beds on the Zwartkop's River and with the characteristic *Trigoniæ* on the Sunday's River, Stow recorded the occurrence of *Cyprina rugulosa* with similar associates. Although the Wood Bed series was not seen in the Zwartkop's River Valley below Uitenhage, the lowest part of the Marine Beds in the Zwartkop's River section, exposed in a clay-pit near Rawson Bridge, yielded *Actæonina atherstoni* and

shells most probably referable to *Bochianites glaber* sp. nov.; the latter has close affinities with European Neocomian forms and occurs at a higher level in the Marine Beds one mile from Rawson Bridge on the main line, up side. It is also worthy of remark that the lowest marine strata found, either at Dunbrodie or in the Zwartkop's River Valley, yielded no single form which suggests stronger affinities to Upper Jurassic than to Lower Cretaceous types; but those very forms, such as *Trigonia tatei* Neum. or *Tancredia schwarzi* sp. nov., which if considered alone might with some reason have been thought to point to a Jurassic age, occur in the higher part of the Marine Beds, associated with characteristic Mollusca of undoubted Neocomian type.

During his visit to the Sunday's River district in 1905, Mr. Rogers found additional evidence to show that the whole of the Uitenhage beds there exposed were deposited with comparatively great rapidity. He found that forms which are represented in the strata by abundant individuals occur much more generally distributed throughout the whole thickness of beds than was at first suspected. Some of the most typical species of the marine facies (for instance, the familiar *Trigoniæ*) were observed to occur, together with layers of lignite, at the very base of the Sunday's River Beds, where Mr. Rogers had expected to find forms characteristic of the Wood Bed facies. These marine forms occur also 300 feet higher in the series, and since the lower beds of the series were seen to be assuming, in some degree, the aspect of the Wood Bed development, the discovery of the familiar marine forms in them occasioned some surprise. Mr. Rogers noted the occurrence of *Hamites* near the mouth of the river, where Stow obtained it at first, but he also found it high up the river in a rock which showed resemblance to the strata of the Wood Bed series. He concludes from his observations during this second survey, that Stow must have been led through insufficient collecting to assign a too restricted vertical distribution to various species. Mr. Rogers believes that from the same cause his own records are likely to prove faulty, and that exhaustive collecting would still more fully demonstrate the extensive vertical distribution of many of the forms throughout the beds exposed.*

The above considerations lend great support to the results of a comparative study of the fauna, namely, that no forms are known to occur in these beds which give definite indications of the presence of more than the equivalent of a single palæontological stage. Allowing, then, that the cephalopods, supported in no small degree

* For the published account of the 1905 survey, consult Rogers (2), pp. 15–33.

by the lamellibranchs, afford satisfactory data for a comparison with European standards, we may safely conclude that no portion of the Uitenhage Series represents a period of time earlier or later than the Neocomian. It must be said, indeed, that the almost entire restriction of *Holcostephanus*, sensu stricto (= *Astieria* Auctorum), to the upper part of the Valanginian and lower beds of the Hauterivian in Europe * suggests much narrower limits, when we consider how important a place is taken by members of this genus in characterising the cephalopod-fauna of the Uitenhage beds.

Leaving, now, the consideration of evidence which leads to these conclusions, we may proceed to compare the Uitenhage fauna with those occurrences in extra-European regions which, in greater or less degree, bear the imprint of a similar facies.

III.—COMPARISON WITH EXTRA-EUROPEAN FAUNAS.

(*a*) *Possible Traces of a Related Fauna in the South-west of Madagascar.*—Douvillé has drawn attention to the occurrence of some lamellibranchs obtained by Lieutenant Boutonnet from deposits situated in the Fiherenga Valley, in the basin of the Isakondry River, east of Tullear.† Mention is made of a large *Trigonia*, said to be analogous to some of the *Trigoniæ* of the Oomia beds in Cutch and of the Uitenhage Series, and with this is associated a shell referred by Douvillé to the genus *Pycnodonta*, and said by him to be closely comparable with *Exogyra imbricata* Krauss (also referred to *Pycnodonta* by Prof. Douvillé). On the evidence of these fossils, the strata containing them are considered by Douvillé to be of Cretaceous age, and Lemoine classes them provisionally as Lower Cretaceous. The account of these fossils so far published is unfortunately meagre, and it must here suffice to have drawn attention to the occurrence of forms in Madagascar which may possibly indicate the presence of a fauna of Uitenhage character.

(*b*) *Comparison with the Fauna of the Oomia Group in Cutch.*—Striking data for correlation are to be found among the lamellibranchs which constitute so large a part of the Uitenhage fauna, and it becomes apparent that some of the conspicuous elements which help to lend a definite character to the assemblage, while finding no exact parallel in the European area, have an unmistakable counterpart in the fauna of the Oomia *Trigonia*-beds. This

* In North Germany, for instance, the restriction of these forms to such narrow limits is well marked. See von Koenen (3), pp. 4, 8, 9.

† Douvillé (2), p. 388; Douvillé (4), p. 215; Lemoine (1), p. 176.

agreement is the more remarkable from the fact that in seeking additional data for comparative study among the cephalopods of the Oomia beds, the indications of community furnished by the lamellibranchs are found to obtain no positive support. The cephalopods described by Waagen* from the Oomia Group, with the exception of the belemnites, do not comprise representatives of any of the genera obtained from the Uitenhage beds, and moreover, when brought into comparison with European forms, seemed to Waagen to indicate a Tithonian or Portlandian age.

Stoliczka† first directed attention to the great similarity between a *Trigonia* collected by Wynne during the geological survey of Cutch,‡ and the South African *T. ventricosa* (Krauss), and the identity of these was afterwards confirmed when the Oomia shell was definitely referred to *T. ventricosa* by Waagen,§ Feistmantel,|| and W. T. Blanford.¶ Feistmantel, in 1876,** noted the close similarity between *Trigonia herzogi* from the Uitenhage beds and a *Trigonia* from the Oomia Group which I have recently described under the name *T. mamillata*. As already pointed out, *T. mamillata* is comparable with *T. herzogi* and the South American *T. transitoria* in the manner in which it exhibits characters somewhat intermediate between those of the Clavellatæ and the Quadratæ, but it bears a still closer resemblance to *T. holubi* sp. nov. Owing to their large and massive shells, and their well-characterised sculptural plan, the members of this group of *Trigoniæ* form a prominent feature in the faunas in which they occur, and supply significant data in the present comparative study.

The basis for comparison is further strengthened by the association of true Costatæ with members of the Scabræ, both in the Oomia and the Uitenhage strata—a fact to which I have already referred. *T. parva* accompanies *T. ventricosa* in Cutch, and although *T. tenuis*, another costate form, has not been recorded from any of the localities where *T. ventricosa* is found, it occurs in beds at least not older than those from which the remaining Oomia *Trigoniæ* have been obtained. In the Uitenhage Series we have *T. tatei*, which, although not closely comparable with *T. tenuis*, and distinguished by much coarser ribbing of the flanks, also shares some of the characteristics by which the Oomia form is contrasted with most of the

* Waagen (1).

† Stoliczka (2), p, 315 (1871).

‡ Wynne (1), pp. 225, 231.

§ Waagen (1), p. 237.

|| Feistmantel (2), p. 164; (3), p. xxxvii.

¶ Medlicott and Blanford (1), p. 261; (2), p. 224. See also Kitchin (1), p. 104.

** Feistmantel (1), p. 116.

Costatæ from the Jurassic rocks of Europe. These distinguishing features are the elongated oval figure, the delicate sculpture of the marginal carina and area, and the elongated form and fine ornamentation of the escutcheon; they lend an aspect of similarity which cannot be overlooked, especially when these lingering examples of a typically Jurassic section are brought into comparison with the majority of European representatives.

Other *Trigoniæ* which serve in most conspicuous manner to characterise the faunas under consideration, and certainly at first sight appear to furnish the strongest corroborative data in a correlation, are the members of the group of *Trigonia v-scripta* in the Oomia beds and the group of *T. vau* in the Uitenhage Formation. The similarity of one of the Oomia *Trigoniæ* to *T. vau* Sharpe seems to have been first pointed out by Feistmantel,* and W. T. Blanford† shortly afterwards suggested that a shell from the Oomia Group, which was ascribed by Feistmantel to the genus *Goniomya*, might in reality represent the African *T. vau*. Which of three Oomia forms was here and elsewhere‡ referred to in this connection is uncertain, but it is possibly the one which I have described under the name *T. v-scripta*,§ although the less well-known *T. dubia* in reality bears a much closer resemblance to *T. vau*, particularly in the outline. When dealing with the Oomia *Trigoniæ* I pointed out that *T. v-scripta*, when adult, more closely approaches an undescribed Uitenhage form which is associated with *T. vau*. This is *T. stowi*, described in these pages, and it is certainly closely allied to *T. vau;* the youthful characters of shape and ornament are practically identical in these two types, but a marked divergence is observed to accompany progressive growth, and the adult forms are perfectly distinct. The characters of the youthful period in *T. v-scripta* are also practically the same as in *T. recurva*, with which it is associated in the Oomia beds, and in this case likewise, wide divergence is exhibited as the adult characters are required. But the marked differences which exist between the essential features in the youthful stage of the two Uitenhage and the two Oomia shells respectively induced me, when describing the Cutch *Trigoniæ*, to distinguish between the "Group of *T. vau*" and the "Group of *T. v-scripta*." Subsequent examination of further material has strengthened the belief that we are here dealing with a case of convergent development, and that close alliance is by no means to be inferred from the

* Feistmantel (1), p. 116. † W. T. Blanford (1), p. 118.

‡ Medlicott and Blanford (1), p. 261.

§ Kitchin (1), p. 70, pls. vii., figs. 6–8; viii., figs. 1–3.

similarity in the adult stage in members of these two groups, however peculiar and striking may be the characters which appear to unite them, and at the same time to differentiate them from all other sections of the genus with which we are acquainted. Since the members of these two groups appear to illustrate mere homœomorphy, their value as evidence in the correlation of the faunas becomes very much reduced, and if dissociated from the forms which accompany them, they could not well be considered to afford proof of contemporaneity. But whatever be the causes that determine the evolution along converging lines in shells which, by their youthful characters, betray a heterogenetic origin, we may in this case safely infer from their occurrence with an association of forms in so many respects similar, that they acquired their common characters at approximately the same time.

Before concluding this comparison of the Uitenhage and Oomia *Trigoniæ*, attention may be directed to certain broad features of general habit which in some measure lend a distinctive aspect to several members of the genus in the faunas under discussion; and it will be noticed that while these features serve in great degree to imprint a facies on the assemblage which brings it into contrast with European occurrences, the same broad distinguishing characters are not confined to one section of the genus, but are shared by members of stocks not intimately related. There is the tendency to great posterior elongation of the shells, and in some cases a siphonal gape; the obliteration of the carinæ with disappearance of a definite demarcation between flank, area, and escutcheon; the dwindling and disappearance of sculpture on the area; and in several instances the situation of the umbones relatively far from the anterior extremity. In the Oomia beds these points are illustrated in varying degree in certain degenerate derivatives of Costatæ, and in the group of *T. v-scripta;* in the Uitenhage beds they are exemplified in *T. vau*, *T. stowi*, *T. rogersi*, and *T. conocardiiformis*. In both *Trigonia vau* and *T. dubia* the parallelism with the genus *Goniomya* cannot be overlooked, and I have previously suggested that if complete shells of these could be procured, they would be found to gape at the siphonal end; this idea is now supported by a specimen of *T. stowi* sent to me from the South African Museum, which is almost uninjured at the siphonal border, and which plainly exhibits a gaping habit.

We do not find further aids to comparison amongst the few Oomia Mollusca which have already been described, and a detailed account of the remaining lamellibranchs collected by Wynne and Stoliczka

from these beds is still in course of preparation; but I am indebted to the Director of the Geological Survey of India for permission to utilise the Indian specimens at present in my keeping for the purpose of this correlation. Several Oomia types at once suggest most strongly their affinity to Uitenhage forms, and these are the following. An *Exogyra* occurring in Oomia beds at the Trummo River is certainly not distinguishable from individuals of *E. imbricata* Krauss, and may at any rate be thus provisionally named; an *Astarte* found in association with *Trigonia ventricosa* and other characteristic Oomia forms very closely resembles *Astarte herzogi* Krauss, though it is not identical with it; there are fragments of a large, coarsely-ribbed *Cucullæa* which, so far as can be seen, shares all the distinguishing features of the strongly characterised *Cucullæa kraussi* Tate; a large *Gervillia* very closely resembles *G. dentata* Krauss, and is probably identical with it;* and lastly, the Oomia beds have yielded specimens referable to the genus *Seebachia*, otherwise only known by *Seebachia bronni* (Krauss), from the Uitenhage Series. Two of these individuals from Cutch very closely resemble *S. bronni*, and it is not improbable that they are identical with it.

The closely similar character of these lamellibranch-faunas is clearly shown when we place side by side the identical, proximate, and analogous types, as follows:—

Uitenhage Beds.		Oomia Beds.
Exogyra imbricata		*Exogyra imbricata*
Cucullæa kraussi		*Cucullæa kraussi*
Gervillia dentata		*Gervillia dentata* ?
Astarte herzogi		*Astarte sp.*, near *herzogi*
Trigonia ventricosa		*Trigonia ventricosa*
Trigonia holubi *Trigonia herzogi*	(Pseudo-quadratæ)	*Trigonia mamillata*
Trigoniæ of the *vau* group		*Trigoniæ* of the *v-scripta* group
Seebachia bronni		*Seebachia bronni* ?

A more critical and detailed study of the Oomia lamellibranchs may possibly reveal further connecting links, but two inferences may already safely be drawn from the general agreement observed to exist between these geographically widely separated faunas. Firstly, despite the absence of clues to correlation derivable from the Cephalopoda, we may conclude that the faunas were approximately con-

* See also W. T. Blanford (1), p. 118.

temporaneous; and secondly, that the lines of intercourse between the two areas were probably much more direct than was formerly believed to be the case.

This correlation appears therefore to be in conflict with Waagen's conclusions concerning the age of the marine Oomia beds, which were thought to be Portlandian, but a brief consideration will show that this difficulty is more apparent than real. Doubts might perhaps be expressed as to the validity of a comparison based solely upon lamellibranch types, and it must be admitted that in many similar cases it would be right to place greater confidence in the evidence of cephalopods; but in the present instance the lamellibranchs compared are peculiarly well characterised, and indeed comprise no single form known in the European area. On the soundness of the evidence which these well-marked types afford, and upon which the above conclusions are founded, I think no doubt can reasonably be cast.

The Mollusca of the marine Oomia beds, shown by Stoliczka to occur in the lower part of the group, cannot be said to give such definite indications of geological age as are to be derived from a study of the Uitenhage fauna. The ammonites from these lower Oomia beds were considered by Waagen to show close affinity with Upper Jurassic forms in Europe, and he believed some of the *Trigoniæ* to corroborate fully his view concerning the Portlandian age.* But a detailed study of the *Trigoniæ* has shown that this belief was not well founded, and the relationship of any of the Oomia forms to the Portlandian Gibbosæ is at the best a matter for conjecture. I have provisionally referred one of these *Trigoniæ* to the group Gibbosæ on the strength of a certain broad similarity of characters, while at the same time recognising the possibility that this form may represent an aberrant derivative of some costate stock. Judged by analogy with *Trigonia retrorsa*, which can only be regarded as a degenerate costate type, the relationship of *T. spissicostata* to the Gibbosæ is extremely doubtful, but nothing more definite on this point can be said until material can be collected in a sufficiently favourable state of preservation to throw light on the nature of the youthful stage. Other Oomia *Trigoniæ* which exhibit characters simulating those of the Portlandian Gibbosæ have been shown to be allied to the section Costatæ, and nothing quite comparable with these diversely modified derivatives is known in Jurassic rocks, though the late adult stage of *T. peninsularis* Coq., from the Aptian of Spain, shows an analogous obliteration of sectional features which was regarded by Lycett to indicate degeneracy. The

* Waagen (1), p. 233 (1875).

value of *Trigonia mamillata* as an indication for age has already been considered, and the supposition of the Cretaceous rather than the Jurassic affinities of this form receives emphatic support from the presence of *Trigonia ventricosa* and *T. pulchra*, both members of the section Scabræ. Though claiming corroboration of his views from *Trigoniæ* which he supposed to be related to Portlandian forms, Waagen did not state that these were found in actual association with his Oomia ammonites; and the fact that none of the critical ammonite-species upon which he relied in his correlation is recorded from any of the localities—such as Goonaree, Oomia, or Huroora,—where the *Trigonia*-beds are well developed, gives room for the suggestion that the ammonites and lamellibranchs may not represent horizons of quite the same geological age. Further, if we examine Waagen's descriptions and figures of the four ammonites which were thought to represent European forms, it may perhaps be allowed that too much reliance has been placed on the evidence they were supposed to afford. Two were referred only with doubt to the respective European species; of the remainder, one represents a type of *Perisphinctes* which, so far as can be judged from the description and figure, does not justify the definite conclusions drawn by Waagen concerning its relation to a European Portlandian form. The other, a single specimen referred to the Tithonian *Perisphinctes eudichotomus* Zittel, is so preserved that the lobe-line is not visible, and a comparison of Waagen's figure with Zittel's original specimen in the Palæontological Collection of the State at Munich shows that the Indian form is rather thicker and more involute, though the agreement is otherwise good.

It is scarcely necessary to dwell at any length on the question of the alleged discrepancy between the evidence of the plant and animal remains in settling the age of the Oomia beds, since this matter has already been so fully dealt with. The plants of the Oomia group were obtained from strata for the most part above the marine beds which yielded the cephalopods and lamellibranchs, but they led Feistmantel to refer these beds to the Middle Jurassic. Even should a revision of the Oomia plants prove the correctness of Feistmantel's view that the flora exhibits Oolitic affinities, there are many reasons why the evidence of the marine fauna must be allowed to outweigh that of the plants in a correlation with European stratigraphical standards.*

Putting on one side the ammonites, the exact bearings of which on this question are somewhat doubtful, it may be said that there is

* W. T. Blanford (2).

nothing in the fauna of the Oomia *Trigonia*-beds to contradict the results reached by a study of the Uitenhage Mollusca, and a consideration of all the available evidence seems to justify the conclusion that here also we are dealing with the part equivalent of the Neocomian in Europe.

(*c*) *Traces of a Related Fauna in the Godavari District and in Hazara.*—Traces of the Uitenhage-Oomia lamellibranch-fauna, as principally indicated by the presence of *Trigonia ventricosa*, have also been found to occur in an outlier of the Tripetty beds about 24 miles north-east of Coconada near the south-east coast of the peninsula of India.* *Trigonia ventricosa* is said to be here accompanied by *Trigonia smeei*, a characteristic fossil of the Oomia Group in Cutch, though it seems possible that this may be *T. crassa*, an Oomia form of similar type.† The small collection of fossils from near Coconada was examined and named by Stoliczka, and it comprises *Inoceramus* and a few other lamellibranchs as well as *Helicoceras* and other remains of cephalopods.

Trigonia ventricosa has also been recorded from strata exposed in the Margalla Pass in Hazara (N.-W. Himalayas), where it is said to be found in profusion.‡ The bearings of these occurrences in a discussion of the broad question of distribution will be considered below.

(*d*) *Neocomian in German East Africa.*—The Lower Cretaceous fossils collected during W. Bornhardt's journeys in German East Africa (1895–1897), and described by G. Müller,§ are of special interest in the present connection, because they exhibit in some measure a Uitenhage facies and also furnish strong links with the molluscan fauna of the Oomia Group. The remains of Cephalopoda are unfortunately very scanty and again fail us as a basis of comparison, but important links are found in some of the lamellibranchs, which include well-characterised *Trigoniæ*. Foremost amongst these is *Trigonia ventricosa*, occurring at a locality ·8 km. north of the Nkundi stream, 29 km. north-west of Kiswere, in strata ascribed to the Lower Neocomian and brought into correlation with the Uitenhage beds by Dr. Müller. *Trigonia beyschlagi* G. Müller, which here accompanies *T. ventricosa* in great abundance, appears to have no counterpart in the Uitenhage beds, but it clearly belongs to the same category of modified Costatæ as *T. smeei* || and *T. crassa* ¶ from the

* King (1), p. 229; Feistmantel (2), p. 164; Feistmantel (3), p. xxxvii.

† Kitchin (1), pp. 42, 43.

‡ Wynne (2), p. 125; Medlicott and Blanford (1), p. 503.

§ G. Müller (1).

|| J. de C. Sowerby (3), pl. lxi., fig. 5.

¶ Kitchin (1), p. 44; pl. iv., figs. 4—6, pl. v., figs. 1–3.

Oomia beds in Cutch; the resemblance to *T. crassa* is indeed very striking, though I have elsewhere stated reasons why these two forms cannot be considered identical.* But *T. beyschlagi* is certainly either closely related to *T. crassa* or illustrates a stage of removal from the normal ancestral costate plan, on some parallel line, quite comparable with that exemplified by the Oomia form. It was probably in consequence of insufficient acquaintance with *Trigonia smeei* that Müller failed to recognise the true relationships of this peculiar shell; the points of similarity to the Uitenhage shell *Seebachia bronni* (Krauss), to which he called attention, are merely superficial, involving the general outward habit only. Uhlig † has expressed the opinion, however, that the grounds for the generic separation of these two forms are hardly convincing; but he can scarcely have compared the figure showing the dentition of the right valve of *Trigonia beyschlagi* ‡ with Neumayr's excellent corresponding illustration of *Seebachia.*§ A glance at these figures proves beyond question that Müller was right in assigning his shell to the genus *Trigonia*, and now it is interesting to find the clue to its narrower relationships by a comparison with the Oomia forms, a detailed account of which had not appeared at the time when Müller wrote.

Amongst the fossils collected at a locality in the district of Ntandi, 35 km. west of Mtshinga, which Müller considered to indicate a Middle Neocomian horizon, a large *Gervillia*, apparently identical with *G. dentata* Krauss, serves as a connecting link to both the Uitenhage and Oomia faunas. There is also a *Ptychomya* (*Ptychomya hauchecornei* Müll.) which, though distinct from *P. complicata* (Tate), may possibly be nearly related to it. *Trigonia bornhardti* Müller, from the same locality, is only so far comparable with the Uitenhage-Oomia *Trigoniæ*, that in common with some of these it exhibits a marked posterior elongation, with absence of sculpture from the area and the posterior part of the flank in the adult shell, in which also the area has ceased to be demarcated from the flank. An *Astarte* from the Oomia *Trigonia*-beds compares very closely with the shells from Ntandi described by Müller under the name *Eriphyla stuhlmanni*, particularly in the character of the hinge and the very deep lunule, though it differs somewhat in the outline and ornamentation; *Astarte herzogi* from the Uitenhage beds also belongs to the same division of the genus.

* Kitchin (1), p. 121. † Uhlig (3).

‡ G. Müller (1), pl. xix., fig. 3.

§ Holub and Neumayr (1), pl. ii., fig. 4*b*.

Still greater interest attaches to a *Trigonia* which strongly recalls the peculiar types belonging to the group of *T. v-scripta* in the Oomia *Trigonia* beds and the Uitenhage group of *T. vau.* This is *T. kühni* Müll., found in strata ascribed to the Upper Neocomian at a locality 23 km. west-south-west of Mtshinga, and it possesses characters which appear to indicate relationship to one of the groups mentioned rather than to the members of other groups with which Dr. Müller has also brought it into comparison. *Trigonia kühni*, it is true, seems to be distinguished from *T. vau* as well as from *T. v-scripta* and its allies both by its less equilateral form and the persistent ornaments of its escutcheon; but to judge from the description, and especially from the figure of an imperfect specimen* which shows the convexity of the anterior profile and the crowded ribs of the frontal series obliquely crossing the growth lines—just as in the Oomia *T. recurva*—there can be little doubt about the position of this shell relative to the main divisions of the genus. Whether it is more closely allied to the group of *T. v-scripta* or to *T. vau* and *T. stowi* sp. nov., cannot be ascertained until more perfect specimens can be obtained and the sculpture of the youthful growth-stage examined.

Of less significance, perhaps, is the occurrence of *Pecten striato-punctatus* Roem., which was found with *Gervillia dentata*, and *Arca uitenhagensis* Müller, which accompanies *Trigonia beyschlagi.* They may be brought into near comparison with *Pecten projectus* Tate and *Arca jonesi* Tate, though little importance could be attached to such types as these, if taken alone. Another *Pecten*, from the same locality as that from which *P. striato-punctatus* was obtained, was considered by Müller to represent very probably *P. cottaldinus* d'Orb., which also occurs in the Uitenhage beds. The relationship of the Oomia fauna to that described from German East Africa is of course what we might expect to find, having regard to the manner in which a close connection between the Upper Jurassic faunas of East Africa and Cutch has been demonstrated by those who have studied the Cephalopoda.

Enough has been said to indicate the position taken by these East African occurrences in a widely distributed Neocomian fauna of southern type, and to show that such connecting links as are available, no less than the general aspect which the fauna, wherever it is developed, derives from the prevalence of peculiarly characterised *Trigoniæ*, plainly serve to unite the molluscan assemblages of these three remotely separated districts in the eastern hemisphere.

* G. Müller (1), Taf. xxv., fig. 8.

Some indications of a western extension of the same type of fauna are to be recognised on the South American continent.

(*e*) *Neocomian in South America.*—Amongst the fossils collected in 1899 by the late J. B. Hatcher from the Pueyrrydon Series in Patagonia* are several lamellibranchs of distinctive type which permit of close comparison with some of those above discussed. They have been described and figured by Stanton,† who was led to ascribe a Lower Cretaceous age to the Pueyrrydon Series, though he was unable to establish a narrower correlation with the formations of other regions. The most striking resemblances to Uitenhage forms are seen in two *Trigoniæ* from the Belgrano beds, *T. subventricosa* Stanton, a member of the section Scabræ, and *T. heterosculpta* Stanton, believed by Stanton to be allied to *T. vau* Sharpe. *Trigonia subventricosa* certainly approaches very closely to *T. ventricosa*, particularly in the wide spacing and robustness of the anterior varices. The differences in the sculpture pointed out by Dr. Stanton appear to be less emphasised when this Patagonian form is brought into comparison with the large and more coarsely ornamented *T. kraussi* sp. nov., which occurs with *T. ventricosa*. But if the relations of height to length exhibited by the figured specimen of *T. subventricosa* be those which characterise the average shells of that form, then there is good ground for the separation of these three members of the Scabræ, which at the same time appear to be united by similar broad features of peculiar form and ornament. They are the only known examples of this particular extreme type, and probably represent a group in this southern developmen parallel with that of which *T. scabricola* Lycett and *T. aliformis* Park. are typical members in Europe.

The ornamentation of *T. heterosculpta* is of such a kind as to recall instantly the conspicuous shells of the groups of *T. v-scripta* and *T. vau*. The principal points of resemblance are thé manner in which steeply inclined ribs of two series on the flank meet to form an angular pattern, and the absence of sculpture from the area and the posterior portion of the flank in the adult shell. *T. heterosculpta* is certainly not to be brought into comparison with the European Undulatæ, but its whole aspect suggests a close connection with the group of *T. vau*. Its near relationship to *T. vau* and *T. stowi* is clearly to be inferred from a comparison of the youthful characters, which are very similar, and affinity with these rather than with the Indian group of *T. v-scripta* is exactly what we might expect to find, having regard to the geographical relationships. The adult

* Hatcher (1). † Stanton (3).

T. heterosculpta differs, however, from its African allies by the less posterior elongation of the shell.

Here again, in the Belgrano beds, we find an associated *Gervillia* of large dimensions, which does not appear to be widely removed from *G. dentata* Krauss, while a large *Astarte* (*A. perlata* Stanton) with short and deeply excavated lunule, may be said to have its parallel in the Oomia beds of Cutch, if we confine the comparison to broad outward features. At a somewhat lower horizon in the Pueyrrydon Series (the Gio beds) *Ostrea tardensis* Stanton, which occurs abundantly, represents a type of *Ostrea* or *Exogyra* which has much in common with *Exogyra imbricata* Krauss; and to judge from the description of *O. tardensis*, it seems likely that these two forms may really be very closely comparable. A special value cannot, of course, be attached to the comparison of such types as these if studied alone, but the resemblance gains significance when viewed in connection with the other Mollusca above discussed. It will be seen therefore, that although the basis of comparison is somewhat slender, yet the occurrences above noted in no slight measure suggest the closest alliance with the molluscan fauna of the South African Neocomian; and it may be added that there is nothing in the Pueyrrydon fauna itself to contradict the assumption that we are dealing with a western part-equivalent of the Uitenhage development.

A search for further traces of the characterising elements of the Uitenhage fauna in the Lower Cretaceous deposits of South America reveals evidences of a very suggestive description. The Lower Cretaceous beds in Bolivia and Chili which have yielded *Trigonia transitoria* Steinmann * are probably of similar age and seem to represent the more northerly equivalents or part-equivalents of the Pueyrrydon Series. *Trigonia transitoria* has also been found to occur abundantly at the Arroyo Triuguico and at Quili Malal in the Argentine Republic, in strata ascribed by Behrendsen † to the Neocomian. It occurs, moreover, with significant associates in the *Trigonia*-beds of Lower Neocomian age exposed on the left bank of the Rio Agrio, opposite to Las Lajas (Argentine Republic); ‡ these beds yield another member of the Pseudo-quadratæ (*T. neuquensis* Burckhardt) and a *Trigonia* very closely resembling the South African *T. conocardiiformis*, § as well as an *Eriphyla* in some respects comparable with the South African *Astarte* (*Eryphyla*)

* Steinmann (1), p. 260; Steinmann (3); R. A. Philippi (1), p. 63; Paulcke (1), p. 297.

† Behrendsen (1), p. 25.

‡ Burckhardt (1), p. 21.

§ Burckhardt (2), pp. 72–75, 111, 112.

herzogi. Dr. Stanton has suggested that a *Trigonia* quoted by Behrendsen* as "*Trigonia* cf. *aliformis* Park." from supposed Upper Neocomian beds at the Arroyo Pequenco may possibly be identical with the Patagonian *T. subventricosa.* It is accompanied by an oyster which Behrendsen identified with *Exogyra couloni,* and found to agree well with the figures of *Ostrea couloni* cited by Bayle and Coquand† from the Neocomian at Arqueros in Chili. The Chilian shells ascribed to *O. couloni* bear a considerable resemblance to the Uitenhage *Exogyra imbricata* Krauss, with which Coquand even later identified them,‡ and accompanying this oyster in Chili is *Trigonia delafossei* Bayle and Coquand, the resemblance of which to *T. ventricosa* has been elsewhere remarked upon.§ Associated with these forms is a *Crioceras* identified by Bayle and Coquand with the European *C. duvali* Lév., thus recalling the analogous association of *Trigonia ventricosa, Crioceras spinosissimum* and *Exogyra imbricata* in South Africa. Of the above-mentioned Mollusca, *Trigonia delafossei, T. transitoria, T. neuquensis,* and *T.* cf. *conocardiiformis* suggest very strongly their relationship to Uitenhage and Oomia forms. It should be noted also that Philippi has described *Trigoniæ* from localities in Chili, which share the characters of peculiar sculpture and siphonal elongation shown by the group of *T. vau* Sharpe, while *T. eximia* R. A. Philippi, from the Tinguirica valley in Chili, appears to be closely related to *T. conocardiiformis* (Krauss) and Burckhardt's *T.* cf. *conocardiiformis.*

IV.—THE DISTRIBUTION OF THE UITENHAGE FAUNA IN RELATION TO SOME THEORETICAL QUESTIONS.

We may now briefly consider in what measure the correlation of the Uitenhage Neocomian fauna with the similar assemblages in German East Africa and in Cutch bears upon the theory of an Indo-African land barrier during early Cretaceous times; and further, we may inquire how far the facts concerning the dispersal of these Mollusca have significance in relation to Neumayr's theory of distribution according to climatic zones, as deduced from a study of the Cephalopoda. The one question is in reality largely bound up with the other, and since in both cases the inquiry is of a so purely palæontological character, it may be of advantage briefly to review the evidence now available. Moreover, it is advisable to glance at

* Behrendsen (1), p. 418.

† Bayle and Coquand (1), p. 37.

‡ Coquand (2), p. 158.

§ Lycett (3), p. 120 (1875); Kitchin (1), p. 108; Paulcke (1), p. 296.

these aspects of the distribution as now known to us, because Neumayr himself attached very great importance to the testimony of the Uitenhage fauna in supporting both the above theories. But at that time it was not known that the links connecting the bivalve-faunas of the Uitenhage and Oomia strata were so numerous or complete as they are now proved to be, while the existence of a related molluscan assemblage in German East Africa was unsuspected.

Although Neumayr was led to the theory of a great equatorial enclosed sea (" Ethiopian Mediterranean ") chiefly by a comparative study of faunas of essentially Jurassic character, yet he felt justified in utilising the Uitenhage fauna also as an aid in this palæogeographic reconstruction.* He believed that the radical differences between the Mollusca of these beds and the more northerly East African occurrences of Upper Jurassic age were an indication that the faunas had for some time lived in distinct areas separated by a land barrier, and from this he thought to derive support for a theory the truth of which had seemed to be attested by evidence of a different character.† In spite of weighty opposition,‡ this theory of a land connection extending from the Indian peninsula through Madagascar to South Africa at the beginning of Cretaceous times has continued to find favour, and it is only comparatively recently that the significance of the palæontological evidence has again been called in question. In view of the presence of some traces of the Uitenhage fauna in the Godavari district and also in Cutch and Hazara, Neumayr supposed that a connection between the equatorial and southern waters must have existed in the form of a strait, the situation of which he believed to be most probably about the present Gangetic plain. The late Dr. W. T. Blanford held a similar view ; § he summarised the main arguments in favour of the theory, suggesting that a shallow water connection near India,—situated very possibly to the eastwards, though not precisely as Neumayr supposed,—would account for the northerly dispersal, and that if this were later converted into land, the "progressive diminution of European species in the three stages of the S. Indian Cretaceous beds would be explained by the increasing effect of isolation." Professor Suess also speaks of these traces of the Uitenhage fauna in Cutch and in the Salt Range as possible indications of an

* Neumayr (3) ; Neumayr (6), pp. 259, 261, 295, 296, 529.

† Stow (1), p. 546 ; H. F. Blanford (1), pp. 534–540 ; Medlicott and Blanford (1), pp. xxxix., lxviii., lxxii., 297.

‡ Wallace (1), pp. 422–427.

§ W. T. Blanford (3), pp. 98, 99.

encroachment of the southern development into the northern region.* With reference to the same subject, Mr. R. D. Oldham wrote: "This barrier does not seem to have been absolutely continuous throughout the jurassic period, or there may have been a mode of communication round the north of the Peninsula of India by which some migration took place, and so the presence of a few Cutch species, which are also found on the east coast of India and in South Africa, is accounted for." †

The belief in this supposed land mass extending through Madagascar and cutting off an equatorial basin from the colder southern ocean, has been thought to receive the strongest support from a comparison of some belemnites of Neocomian age found at localities in the north-west of Madagascar.‡ Neumayr found that while these belemnites belong to groups which in their distribution are essentially associated with the equatorial and South European development, the single belemnite (*B. africanus* Tate) then known from the Uitenhage beds is not closely comparable with any of these, but belongs to a group distributed in the northern hemisphere only in the boreal region and in the northern part of the temperate zone.§ From this he drew the conclusion that these representatives of contrasted groups of belemnites belong to faunas of radically different type, which flourished in separate geographical regions. Much has been made of this piece of evidence, which, so far as it goes, is admittedly very suggestive. The late Dr. W. T. Blanford || more recently drew attention to some independent evidence of another kind which indirectly lends support to the theory of an Indo-African land barrier in pre-Tertiary times, but this only bears on the general question of the existence of a barrier, without any possible reference to its state of completeness during any part of the Cretaceous period. Dr. F. Kossmat ¶ has shown that so far as the distribution of the faunas of Ariyalur (Senonian) age was known at the time when he wrote, the evidence was in favour of a barrier separating the waters of the Mediterranean province (with its easterly extension) from the South Indian ocean. He concluded from a careful comparative study of the Cephalopoda that the fauna represented in the Trichinopoly-Pondicherry districts had intercourse with the European area only by way of Natal and to the west.

The distribution of the much older Uitenhage fauna must certainly

* Suess (1), p. 536.

† In Medlicott and Blanford (2), p. 211.

‡ Newton (1), p. 333.

§ Neumayr (5).

|| W. T. Blanford (4).

¶ Kossmat (1), Kossmat (2).

lead us to a somewhat different conclusion concerning the relation of the equatorial and the southern ocean at that period. In order to form an approximately correct picture, we must at least compare faunas of similar age, for it is probable that migration from one area into another may take place exceedingly rapidly when measured by geological standards, and that a fauna may thus become quickly modified as regards some of its most salient characteristics. Dr. Kossmat has brought forward evidence to show that in the migration of Upper Cretaceous cephalopods "the distribution of the species did not require any geologically measurable time." * In contrasting the Uitenhage fauna with any occurrences on the western shore of his equatorial sea, Neumayr was not able to compare with contemporaneous faunas, except perhaps that of the Belemnite-beds in the north-west of Madagascar. But in this case the possible grounds of comparison were of the most slender description, since in the Neocomian of Madagascar the known fauna consisted solely of belemnites ; and hence the very hazardous nature of the generalisations which Neumayr was led to make as a result of the comparison. It is very probable that the great contrast between these faunas may owe its strength in no slight measure to differences of local facies, a factor which does not seem to have been sufficiently taken into account ; † the Belemnite-beds of Madagascar probably represent deeper water conditions, in contrast to the littoral character exhibited by the Uitenhage molluscs. Moreover, it is easy to conceive that the lines of communication between the two areas were in reality somewhat indirect, without necessarily accepting Neumayr's extreme interpretation of the facts. It may be admitted that the arguments drawn from evidence furnished by distribution at an earlier and a considerably later age decidedly favour the view that in Neocomian times a ridge extended from India to South Africa ; this, however, may have been only partially elevated into land, and one or more intervening tracts of shallow water would suffice to allow passage from north to south. Pavlow ‡ and Uhlig § have pointed out the very close affinity between species of *Holcostephanus* from the Uitenhage beds and *H. schenki* (Opp.) from the Spiti Shales, while Kossmat has also remarked on the close relationship between Uitenhage fossils and Lower Neocomian forms in the Salt

* Kossmat (3), pp. 78–81.

† Since these sentences were written (in 1903), Lemoine has expressed the same opinion ; see Lemoine (1), p. 391.

‡ Pavlow and Lamplugh (1), p. 493 (p. 135 of authors' separate copy).

§ Uhlig (4), p. 132.

Range.* He thinks this cannot readily be explained except by an oceanic connection separating India and Africa. In addition, the question of the existence of very strong palæontological links connecting the Uitenhage fauna with that of the marine Oomia beds in Cutch, concerning which some doubts might at one time have been held, and were, in fact, expressed, may now be considered to have been definitely settled, and this cannot be lightly set on one side. Further, the recent discovery in the Uitenhage beds of belemnites which are related to the Neocomian Hastati of Europe, a group represented in the north-west of Madagascar, has undoubted significance, and helps materially to invalidate Neumayr's ingenious argument.

There is, indeed, no evidence that the means of communication lay only by way of the east coast of the Indian peninsula and thence to Cutch, and while the occurrence of *Trigonia ventricosa* near Coconada might seem to suggest that the submergence of the ridge was not so great as to preclude the migration of some littoral types, the discovery of a Neocomian fauna in German East Africa showing relationship to that of the Uitenhage Series, throws some fresh light on the question and appears to require a more direct line of communication. This may most reasonably be supposed to have existed in some nearer passage, situated between Africa and India, as above indicated. The seeming absence of the Uitenhage cephalopods or of the genus *Seebachia* from the Neocomian of German East Africa may very probably be due to our imperfect knowledge of the fauna in this less frequented district. The Cephalopoda of the Uitenhage Series, although perhaps rarer in their occurrence than the lamellibranchs, are well known because these beds have been more thoroughly and more frequently searched than those in German East Africa.

We may here note Dr. G. Müller's suggestion † to the effect that Stow's record of Uitenhage lamellibranchs from the Zambesi,‡ which was discredited by Holub,§ may after all prove to have been authentic. Until this record can be substantiated, however, the suggestion may perhaps be without special significance as pointing to the direction in which a fauna of intermediate character may be sought for. The fact that it is not in the nearer East African Neocomian, but in the more remote Oomia strata that the higher percentage of Uitenhage forms is found to occur, may possibly indicate that the passage between north and

* Kossmat (3), p. 78, footnote.

† G. Müller (1), p. 571.

‡ Stow (1), p. 505, in editorial footnote.

§ Suess (1), p. 541, note 28.

south was not situated in close proximity to the present African continent. On this point nothing definite can at present be said, and it must be admitted that recent advances in our knowledge of the Mesozoic rocks in Madagascar and on the east coast of Africa can only serve as a warning against premature speculation on such a subject. As regards Jurassic deposits, we now know that, contrary to formerly held belief, these are not confined to the north-west coast region of Madagascar, for strata of Oxfordian age have been shown to be present in the south-west part of the island, in the basin of the River Isakondry, east of Tullear.* Professor Douvillé considers that in these deposits the contrast in faunistic and lithological facies to the strata of corresponding age in the north-west of the island may be accounted for by different conditions of sedimentation, and is not to be ascribed to deposition in separate basins.† As remarked on a previous page, deposits which may perhaps be equivalent or partly equivalent to the Uitenhage Series, also occur in the Isakondry basin. Prof. Douvillé has given brief notices of the fossils found in these beds by Lieutenant Boutonnet, and has drawn attention to the occurrence here of a large *Trigonia* which, he says, recalls the *Trigoniæ* of the Oomia beds in Cutch and the Uitenhage beds in South Africa. Associated with this is a shell which closely resembles *Exogyra imbricata* Krauss (referred to by Prof. Douvillé under the generic name *Pycnodonta*).‡ The same region in Madagascar has furnished a Cenomanian fauna which is said to show relations to the corresponding faunas both of Europe and Southern India.§ Concerning the conditions at a later period, the discovery of fossiliferous Senonian deposits at Fanivelona and Marohita on the east coast of Madagascar is very significant. The fossils found on the River Sakaleou, 10 km. from the coast and 30 km. north of Mahela, are stated by Prof. Boule to include forms which show clear relationship to the fauna of Ariyalur type in Southern India and also to the Senonian of Baluchistan.|| Some of Prof. Boule's remarks on this subject are as follows: "Hitherto it has been admitted that the eastern coast of Madagascar is lacking in all sedimentary deposits of the Secondary era, and this belief has played an important rôle in the theories expressed by various scientists; Oldham, Neumayr, Suess, Kossmat, etc., on the former distribution of land and sea and concerning the existence, during the Secondary era, of a continent

* Boule (2), p. 131. † Douvillé (3), p. 435.

‡ Douvillé (2), p. 388; Douvillé (4), p. 215; Lemoine (1), p. 176.

§ Boule (1), p. 184. || Boule (2), pp. 132, 133.

uniting Africa with India (*Lemuria* of the zoologists). This hypothesis appears to be justified in the case of the Triassic epoch, since there are close relationships, both from the palæontological and stratigraphical point of view, between the deposits of India and of the south of Africa (fauna with dicynodont reptiles; *Glossopteris* flora); but the hypothesis can no longer be applied to the Jurassic epoch, for various reasons which would take too long to enumerate here. As to the Cretaceous epoch, the discovery, on the east coast, of the fossils mentioned above, compels us to admit that our great colony was already an island. The affinities of these fossils with those of the west as well as with those of the east of India support the same conclusion." * Haug has confirmed the analogies between the Upper Cretaceous faunas of India and Madagascar, but he considers that the discovery of Senonian deposits on the east side of Madagascar does not weaken the hypothesis of an Indo-Malagasy continental mass.† In discussing M. Haug's paper, Prof. Boule maintained that the theory of a land barrier is now very difficult to uphold, and thought that recent discoveries in Madagascar greatly weaken the theory.‡ Again, with M. Thevenin, he has written as follows: "If it has truly existed, the Indo-Malagasy continent must have been reduced then to a long Indian peninsula or to a suite of islands situated on positions where one to-day observes depths of 6,000 metres." §

Turning now to the African mainland, it may be remarked that from the coast, as far south as Delagoa Bay, an Aptian fauna has been described which, while later than the Uitenhage fauna, and consequently not to be closely compared with it, contains cephalopods exhibiting the closest relationship to those of the Aptian with *Acanthoceras martini* in Southern Europe.|| This in itself appears to be sufficient to throw doubt upon the existence of a barrier near the African coast at that period. Further, the recent discoveries of an Upper Cretaceous fauna in Mozambique, showing clear affinities with the Southern Indian development (Utatur and Ariyalur stages),¶ seem quite to disprove the existence of a permanent barrier even at the approach of that later time which we have hitherto thought to furnish the most sure evidences of separation. It is apparent that

* See also Boule (3); Boule (4), pp. 684, 685; Douvillé (4), p. 215; Boule (5); Boule and Thevenin (1), p. 59; Lemoine (1), p. 232.

† Haug (1), p. 397. ‡ Haug (1), p. 398.

§ Boule and Thevenin (1), p. 59. See also Woods (4), p. 348.

|| Kilian (2); Kilian (3).

¶ Choffat (1); Choffat (2); Choffat (3); Lemoine (1), p. 396.

although the known evidence seems to be on the whole destructive of Neumayr's view regarding the isolation of the Uitenhage fauna, yet any attempt to reconstruct precisely the geographical relations of the region under consideration in early Cretaceous times must still remain purely within the realm of speculation.

One point at any rate is clear, that the argument based upon the sharp contrast between the Neocomian fauna of Cape Colony and comparable occurrences situated on the African continent to the north of the supposed separating ridge, can no longer be utilised. We are now able to compare contemporaneous faunas in which, so far as the lamellibranch element is concerned, the validity of the comparison is not impaired by differences of facies due to local conditions; and the supposed contrast is no longer perceivable. The apparently almost complete restriction of the Uitenhage cephalopods to the southern district in Africa may still seem to require some further explanation, but should scarcely occasion more surprise than the fact that only one species from the Neocomian Belemnite-beds of north-west Madagascar is included in the East African fauna described by Müller, although both inhabited the equatorial waters. As a further example of the risk of making premature deductions from the apparent dispersal of cephalopods, it may be noted that not one of the cephalopod-genera of the Uitenhage area has been recorded from the Pueyrrydon series in Patagonia, although the occurrence of these forms there would be exactly in accord with a distribution regulated by the principles upheld by Neumayr. The evidence of the other Mollusca seems, indeed, to lend every support to the view that a continuous shore-line extended between South Africa and South America, and this idea has gained further justification from the recent work of C. Burckhardt.

This brings us to inquire whether the Uitenhage ammonitoids are in reality so peculiarly restricted in their geographical distribution as at first appears. It is certainly remarkable that no definite traces of them have been found in the African equatorial regions,* while close allies are known from Western Europe and the Himalayas. Indeed, it may be said that these cephalopods exhibit in the main a distinctly "Middle European" facies, and thus at first sight seem to lend support to Neumayr's distribution theory.† We have seen that amongst the lamellibranchs, leaving out of account

* A very badly preserved ammonite found at one of the localities visited by Bornhardt has been referred to the genus *Holcostephanus*. Whether this indicates the presence of Uitenhage forms, which appears not improbable, further collecting alone may be expected to decide.

† Neumayr (2).

many apparently cosmopolitan forms, some of the most characteristic and highly specialised types follow a very different distribution. It might perhaps be supposed that members of this class, owing to their relatively passive habit, were more inured to varied environment than the cephalopods, while these, on the other hand, possibly equipped with better facilities for exercising choice of station, were more delicately adjusted to conditions of temperature, ood-supply, and other special characters of environment. Nothing, however, is known regarding the exact mode of life of these cephalopod-types; but while the evidence so ably handled by Neumayr seemed for some time inevitably to urge the acceptance of his fascinating theory, a body of facts has since been brought to knowledge which must surely indicate that climatic conditions played at the most an insignificant part in regulating the dispersion of ammonites, and that distribution of land and sea is in reality to be recognised as the most potent determining factor.* It is therefore scarcely conceivable that in the case of the Uitenhage fauna a distribution of land and sea which permitted the migration of well-characterised lamellibranch-forms over such a wide area, could have offered any obstacles to a similar geographical range for some, at least, of the cephalopod types. It must be remembered, too, that members of the true *Holcostephanus* (Pavlow's *Astieria*) have been described from the Mazapil district in Mexico.†

It becomes plainly apparent that with the limited evidence as yet available, the only reasonable course is to suspend judgment concerning the exact significance of the Uitenhage Cephalopoda in this question of distribution, and a definite pronouncement will only be justifiable when our knowledge of the Indian and African Neocomian faunas is more complete. In view of the facts to which reference has already been made, it is necessary to abandon the supposition that these cephalopods were excluded from the equatorial waters; but in the meantime there is nothing to show whether the absence of these forms from the Neocomian of German East Africa and Cutch is merely apparent,—in which case the fact of their occurrence there may become established by extended search,—or whether it is real, and to be accounted for by causes of a local character. In this connection it is well to bear in mind that in Europe certain Cephalopoda of the Chalk, though living under conditions which might be expected to have assured exceptional uniformity of environ-

* Kossmat (2), p. 53; Nikitin (2); Burckhardt (2), pp. 115–135; Solger (1), pp. 220–221; G. Boehm (2); Tornquist (1), p. 285; Ortmann (1); Stanton (2) Burckhardt (3), p. 179.

† Burckhardt (3), p. 183–185.

ment, were nevertheless peculiarly local in their occurrence, even within a relatively restricted area. The greater, then, is the necessity for caution in generalising from scanty data regarding the insufficiently explored littoral Neocomian deposits with which we are dealing.

V.—DESCRIPTIONS, CRITICAL NOTES, AND LISTS OF FOSSILS.

In the records of occurrence accompanying the following descriptions, it will be understood that when no collector's name is mentioned, and no other indications are given, the specimens in question were obtained by Mr. A. W. Rogers and Mr. E. H. L. Schwarz in 1900 or by Mr. Rogers in 1905. The numbers quoted in parentheses refer to numbers printed on labels affixed to the specimens. All the specimens obtained in 1900 by Messrs. Rogers and Schwarz, and some also sent to me from the collection in the South African Museum, are labelled with plain numbers printed on yellow paper. Those collected in 1905 by Mr. Rogers have blue labels bearing a number followed by an alphabetical letter. A few of the specimens from the South African Museum and all those comprising the collection obtained by Miss M. Wilman at Coega are without numbers.

With the exception of *Holcostephanus baini*, *H. modderensis*, and *H. wilmanæ*, all the fossils fully dealt with in these pages are represented in the collections submitted to me by Mr. Rogers; but it need scarcely be remarked that these only include examples of about two-thirds of the species of invertebrates known to occur in the Uitenhage Series, and it may be added that the published accounts of several types figured or described by Sharpe and Tate call for critical revision at some future time. To deal exhaustively with all the invertebrate forms hitherto recorded from the Uitenhage beds is beyond the scope of this memoir; and since a single compiled list of the whole fauna, including names taken without criticism from other works, would be open to obvious objection, it will be found that lists of species with localities given at the close of this descriptive section, contain names which, except those of the ammonites just mentioned, refer only to specimens entrusted to me by Mr. Rogers. Additional notes of occurrences, however, frequently accompany the following descriptions and comparisons, and are based on specimens preserved in the collection of the Geological Society of London or in the British Museum (Natural History). A few forms not dealt with

in detail below have already been briefly noticed in the second section of this paper, in so far as it seemed necessary to draw attention to their significance in reference to the question of geological age: the names of these, and the remainder of the invertebrate fossils of the Uitenhage Series which have hitherto been recorded, are brought together in the supplementary list and brief accompanying notes with which the present section of this memoir concludes.

In those few instances in which Uitenhage forms are referred to European species, I have refrained from burdening the subjoined accounts with full synonymic lists, but have given a reference to the original description and, where possible, to a recent work in which fuller guidance to the literature of the species may be obtained. Throughout the following pages, however, nomenclatural references are restricted to those works which contain such information as to insure, in my belief, the truly synonymic value of the citations.

In the description of the Gasteropoda a conventional orientation is employed for the sake of clearness, and when use is made of the terms "above" and "below" in this connection it is assumed that the specimen be held with the apex directed vertically upwards. The terms "nepionic" and "neanic," occasionally employed with reference to the young or immature stages in some of the lamellibranchs described below, are so well known and so frequently used as to call for no explanation here.*

For an account of the available geological information in connection with the occurrence of the specimens obtained in 1900 reference should of course be made to the Report by Messrs. Rogers and Schwarz,† but this may be supplemented by a brief note contained in a letter written to me by Mr. Rogers, to the following effect: "The specimens from Dunbrodie and Blue Cliff are from the lower beds of the Uitenhage Series, those from the Clay Pit near Rawson Bridge from the lowest marine beds in the Zwartkop's River section. Those from the Grass Ridge, Uitenhage, and from the kloofs near Red House and Picnic Bush belong to the highest beds we found, and the specimens from the Graaff-Reinet railway section and those from the main line up-side of Rawson Bridge are from the middle portion of the marine beds." I am informed that the collection obtained at Coega by Miss Wilman was made at a locality on the farm of that name, though outside the river valley, while the label "Coega River" refers to a section in the river valley on the same farm, but probably on a rather lower horizon in the Marine Beds.

* See Hyatt (1); Jackson (1), p. 293; Buckman and Bather (1); Hyatt (2), p. 94.

† Rogers and Schwarz (1); also Rogers (1), pp. 281–292.

In the case of the specimens from the collection of the South African Museum labelled "Sunday's River," no more detailed account of locality is available, but these are all typical Mollusca of the Marine Beds or Sunday's River Beds. Of all the fossils examined, the only forms which indicate fresh-water conditions are the *Unio* from the Wood Beds of the Bezuidenhouts River, below Blue Cliff station, and a single specimen of *Limnæa* from the section at Buck Kraal, Sunday's River. Whatever may be the exact relation of the fossiliferous beds exposed below Dunbrodie (occurring below a band containing plant impressions) to the main part of the "Wood Bed" series, the fauna from Dunbrodie is essentially a marine one: as already stated in the second section of this paper, there is no reason on palæontological grounds to suppose that this small marine assemblage, characterised by the prevalence of Gasteropoda, is materially older than the fauna yielded by the *Trigonia*-bearing Marine Beds.

The collection obtained by Mr. Rogers from the Marine Beds of the Coega River and Sunday's River valleys, in 1905, includes some interesting additions to the fauna. For full information concerning the occurrence of these and commoner associated forms, the recent report by Mr. Rogers should be consulted.* This work adds materially to our knowledge of the Sunday's River Beds, particularly with regard to the vertical distribution of many of the Mollusca in the extensive sections examined; but the results in no way strengthen the hope that a scheme of zonal subdivision of the Marine Beds may soon be within reach of attainment. On the contrary, the evidence obtained by Mr. Rogers, as already mentioned, seems to emphasise the striking similarity in the aspect of the fauna throughout the whole thickness of beds exposed.

The few specimens found by Mr. Rogers in a patch of marine Uitenhage beds at Knysna Estuary † only represent the product of a hasty search, and it is believed that careful collecting at this new locality may yield good results.

Class ANTHOZOA.

Genus THAMNASTRÆA ‡ Lesauvage.

Thamnastræa sp.

There are several specimens of a *Thamnastræa* from the locality between milestones $24\frac{1}{2}$ and $24\frac{3}{4}$ on the railway between Uitenhage

* Rogers (2), pp. 22–33.

† Schwarz (2), pp. 50, 74.

‡ For remarks on the correct application of this generic name see Gregory (2), p. 131.

and Graaff-Reinet (345–349). These occur in a hard limestone matrix, and the coral itself is replaced by crystalline carbonate of lime and is in a condition unfavourable for detailed study. The corallum is relatively slender, subcylindrical and branching in form. The calicinal centres are situated at about 2 mm. from one another.

Prof. J. W. Gregory has seen a specimen of this form, and considers that it may be correctly assigned to the genus *Thamnastræa.* In view of the scanty material so far obtained, and its imperfect condition, a fuller description and comparison with described species may be deferred for the present.

Class **ANNELIDA.**

Genus SERPULA Linnæus.

Serpula cf. concava (J. Sowerby).

Plate II., figs. 1, 1*a*.

Cf. 1814. *Vermicularia concava* J. Sowerby, The Mineral Conchology of Great Britain, vol. i., p. 125, Tab. 57, figs. 1–5.
,, 1836. *Vermetus concavus* J. de C. Sowerby, Trans. Geol. Soc. Lond., ser. 2, vol. iv., p. 343, pl. xviii., fig. 10.
,, 1884. *Vermicularia concava* R. Damon, Geology of Weymouth, Portland and Coast of Dorsetshire, 2nd edition, p. 128, fig. 48.

Description.—The tube is wound in the form of a very flat spire, widely umbilicated, with the apical part not projecting above the outside whorl when viewed in lateral profile. The whorls are in close contact, or slightly embracing. The tube is of slightly flattened cylindrical or oval section, the flattening at right angles to the axis of the spire. After the third whorl the tube ceases to be coiled and becomes free. The surface of the tube is marked by numerous irregular transverse wrinkles and furrows.

Dimensions.—

Greatest diameter across the whorls .... 9 mm.
Greatest external diameter of the tube at the close of the coiled stage .... 3 ,,

Occurrence.—A single specimen was found between milestones

$24\frac{1}{2}$–$24\frac{3}{4}$ on the railway between Uitenhage and Graaff-Reinet (332), in the railway cutting.

Remarks.—The specimen described in all probability has not attained its full growth, and the manner in which the tube for about the last 2 mm. of its length has grown free from the coil suggests that we have only the commencement of an uncoiled stage illustrated in this individual. The subsequent growth of the tube was probably in a more or less nearly straight line as in *Serpula concava*, and it is impossible to say what dimensions the detached portion of the tube might attain.

In general aspect this *Serpula* very closely resembles *S. concava* (Sow.) (Upper Greensand), and agrees in the dimensions of the coiled stage, but without a sufficient number of specimens for critical comparison nothing further can be said regarding its actual affinities. A similar form from the Neocomian of France was figured by Leymerie as *Serpula lituola.** In the general habit and mode of growth there is also resemblance to *S. damesi* Noetling, † from the Cenomanian boulders of North Germany, but the African form differs in the smaller number of whorls, the smaller dimensions, and the thinner walls of the tube.

Serpula pinchiniana Tate.

1867. *Serpula* (*Vermilia*) *pinchiniana* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 163, pl. ix., figs. 10*a*–*c*.

The large cylindrical tubes of this form are sometimes seen attached to massive lamellibranch-shells such as *Exogyra imbricata* Krauss, or one of the pseudo-quadrate *Trigoniæ*. The adherent stage is irregular in the direction of its growth : it sometimes follows a sinuous course, and in some cases the tube is bent sharply back upon its path and grows over itself. The generally smooth surface of the tube is occasionally marked by irregular annular thickenings.

Mr. Rogers collected specimens from the Cliff on Buck Kraal, Sunday's River, attached to *Trigonia herzogi* (122h), and at the left side of the Coega Valley, half a mile down from the railway (458g, on *Trigonia holubi*). Another example is attached to a valve of *Exogyra imbricata* from the Sunday's River (303), belonging to the collection of the South African Museum.

* Leymerie (3), pl. 6, fig. 5.

† Noetling (1), p. 10 [206], Taf. i., figs. 8–10.

CLASS LAMELLIBRANCHIATA.

GENUS PECTEN O. F. Müller.*

SUB-GENUS SYNCYCLONEMA F. B. Meek.

PECTEN (SYNCYCLONEMA) ORBICULARIS J. Sowerby.

Plate II., figs. 2, 3.

1817. *Pecten orbicularis* J. Sowerby, Mineral Conchology of Great Britain, vol. ii., p. 193, tab. 186.

1902. *Pecten* (*Syncyclonema*) *orbicularis* H. Woods, Mon. Cret. Lamell. Engl., vol. i., part iv., p. 145, pl. xxvii., and text-fig. 1. (Palæontographical Society.)

Two specimens sent to me from the South African Museum appear to differ in no respect from typical examples of this widely distributed form. One of the specimens, a single valve, has a delicate concentric banding extending over the whole surface—a character by which it may be recognised as a right valve. With the exception of its imperfect preservation in the umbonal region and its somewhat smaller dimensions, this specimen agrees very perfectly with the right valve figured by Mr. Woods in pl. xxvii., fig. 11 of his monograph (see above). The other specimen appears smooth to the naked eye, but shows minute and delicate, faint concentric markings under the lens. This represents a left valve, and it has the anterior ear preserved. Length 26·5 mm.; height 28 mm.

A small specimen (a left valve) referable to the same species was found by Mr. Rogers in the Coega River Valley. Length 13 mm.; height 15 mm.

Locality.—Sunday's River (279, 280). Coega Valley, on the left side of the valley, half a mile down from the railway (453g).

SUB-GENUS CAMPTONECTES F. B. Meek.

PECTEN (CAMPTONECTES) COTTALDINUS d'Orbigny.

Plate II., fig. 4.

1847. *Pecten cottaldinus* A. d'Orbigny, Paléont. Franç., Terr. Crét. vol. iii., p. 590, pl. 431, figs. 7–11.

* For a full account of the generic and sectional divisions of *Pecten* see Verrill (1); for further references to recent literature on this subject consult Woods (3), vol. i., p. 145 (1902).

1902. *Pecten* (*Camptonectes*) *cottaldinus* H. Woods, Mon. Cret. Lamell. Engl., vol. i., part iv., p. 156, pl. xxix., figs. 1–3. (Palæontographical Society.)

A specimen collected by Messrs. Rogers and Schwarz agrees so closely with *Pecten cottaldinus* that it can only be considered identical. It is a right valve in which, unfortunately, the anterior ear is the only portion which retains the shell wholly preserved; the remainder of the valve is for the most part in the form of a cast. Here and there, where some of the inner layers of the shell are adhering to the cast, a faint and broad concentric waving is seen; this, however, does not seem to be markedly impressed upon the cast and appears to die out towards the posterior margin. It probably stands in relation to shell structure and not to surface sculpture, for the faint folds are too broad to correspond with the concentric surface markings which are exhibited by European specimens. The specimen agrees with *P. cottaldinus* in all characters of proportion and outline, as well as in the shape and relative size of the ears and the deep byssal notch.

Dimensions.—Length 38 mm.; height 42 mm.

Occurrence.—Dunbrodie, in the cliff below the old school-house on the right bank of Sunday's River (305, 306).

Remarks.—This form is well distributed in the Neocomian (principally the Hauterivian) and Aptian of Europe, and it has also been recorded by G. Müller from the Neocomian of German East Africa.

Pecten (Camptonectes) projectus Tate.

Plate II., figs. 5, 5*a*.

1867. *Pecten projectus* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 155, pl. ix., fig. 6.

Supplementary Descriptive Note.—The ears are very unequal and the byssal notch deep. The delicate ornamentation of the valve surface presents a very variable aspect in different states of preservation, and under different conditions of illumination and enlargement. In frequent instances it appears to consist of fine, radiating, impressed linear striæ, diverging from the middle line and increasing by bifurcation when traced towards the valve margins. When the surface is not very perfectly preserved, these lines may appear to be separated by plain flattened interspaces, while the lines themselves may exhibit an imperfect punctate structure. Where the surface is perfectly preserved, however, the ornaments are observed to be of

a much more complex nature. If, in a suitably preserved adult specimen, the surface half-way down the valve and below this be examined under slight magnification and with favourable illumination, it is seen that the raised interspaces or minute flattened ribs themselves exhibit a peculiar punctate structure on that side of the rib nearest to the lateral margin of the valve. This is developed in such a way that the outer margin of each little rib is cut into by a series of minute wedge-shaped indentations, which leave more prominent projecting portions of the rib standing out somewhat after the manner of the hydrothecæ on a graptolitic stipe. In some cases the successive wedge-shaped grooves may almost cross the rib, but for the most part the margin of the rib which is nearest to the middle line of the valve is straight and entire.

Another peculiarity of the ornamentation is seen in some cases in the manner in which, when the radial striæ are traced upwards from the valve-margin towards the place of convergence at the middle line, by favourable illumination they may be observed to be continued upwards across the middle line, giving rise to a slight intercrossing here.

In the left valve the anterior ear is large and rectangular, the posterior ear small. This valve has a rather more equilateral aspect than the right valve, which is sometimes very markedly inequilateral.

Dimensions.—

	(1)	(2)	(3)
Height	13 .	19 .	21 mm.
Length	12 .	17 .	20 ,,

No. (3) is Tate's figured type specimen.

Occurrence.—Railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the Uitenhage to Graaff-Reinet railway (297, 350); also obtained by Miss M. Wilman at Coega River. Tate says: "Collected by Dr. Rubidge in a soft, yellowish-grey, sandy limestone at the Zwartkop River Heights, and at Prince Alfred's Rest; in both localities it is frequent."

Remarks.—The notched sculpture of the ribs, described above, may be well observed when the preservation is exceptionally good. It appears only in faint traces in a portion of the surface of one of the specimens examined by Tate, and in other individuals less well preserved the markings only consist of radiating linear striæ, obscurely punctate in places, with smooth interspaces. A right valve from the Coega River, which agrees closely with Tate's figured type, has the surface so well preserved that the intimate details of sculpture exhibited call for the above additional descriptive note.

The delicate notched structure is also well shown in specimens from the above-mentioned locality near Uitenhage.

Tate brought this shell into relationship with *Pecten lens* Sowerby, a Jurassic form; and although it shares with this and with the Portlandian *P. morini* de Loriol* some of the principal features which characterise these familiar Jurassic types, yet it may equally well be brought into comparison with Cretaceous forms. The Jurassic shells mentioned, besides differing in the outline, have simply striæ with a punctate structure, but no encroachment of this sculpture into the interspaces between the linear striæ. *Pecten suprajurensis* Buvignier,† an Upper Jurassic form, approaches much more closely to *P. projectus* in general character and outline, possessing a similar bulging frontal profile, but is likewise merely ornamented by delicately punctate linear striæ with smooth interspaces, attaining, moreover, much larger dimensions. *Pecten buchi* Roem.,‡ also Upper Jurassic, is well distinguished by its almost equilateral outline and by the minute transverse striations which cross the interspaces between the radial linear striæ.

Pecten striato-punctatus Roemer,§ from the Neocomian and Aptian of Europe, is more equilateral in outline and is more delicately ornamented; the punctate structure is much more minute and confined wholly to the striæ, leaving the very narrow intervening spaces smooth.||

Pecten curvatus Geinitz,¶ though having greater relative height than *P. projectus*, sometimes seems to approach the somewhat inequilateral form of this, though in figures of other shells which have been united with *P. curvatus*** the valves are almost equilateral. Although Geinitz figured the magnified ornamentation of the valve-surface so as to produce an aspect of sculpture widely different from that given for instance by Reuss, yet it appears from the descriptions that punctate linear striæ with smooth interspaces characterise these forms.

Nilsson's *P. virgatus*, of Upper Chalk age from Sweden,†† is

* de Loriol and Pellat (1), p. 107, pl. x., fig. 6.

† Buvignier (1), p. 24, pl. xix., figs. 21–23.

‡ F. A. Roemer (1), pl. xiii., fig. 8 (1836), and Nachtrag, p. 27; de Loriol, Royer and Tombeck (1), p. 389, pl. xxii., figs. 12, 13.

§ F. A. Roemer (1), Nachtrag, p. 27; d'Orbigny (3), p. 592, pl. 432, figs. 4–7 (1847); Woods (3), vol. i., p. 157, pl. xxix., figs. 4–6 (1902).

|| See also figures given by de Loriol under the name *P. arzierensis;* Loriol (3), pl. iv., figs. 3–5.

¶ Geinitz (1), p. 16, Taf. iii., fig. 13.

** Geinitz (2), Theil i., p. 193, Taf. 43, fig. 15 (1872); Theil ii., Taf. 10, fig. 1, (1872); Reuss (1), part ii., p. 28, Taf. 39, fig. 6 (as *P. divaricatus*).

†† Nilsson (1), p. 22, Tab. ix., fig. 15.

more equilateral and more coarsely ornamented than *P. projectus*, and it has been shown, moreover, by Hennig* that Nilsson's unsatisfactory figure is misleading; this shell really has relatively strong ribs with linear interspaces, increasing by division and insertion and not diverging from the middle line in the manner represented by Nilsson. The delicate transverse striæ which cross the radial ornaments are scarcely comparable with the notching of the "ribs" shown by *P. projectus*. The shell from the Gosau beds described by Zittel under the name *P. virgatus*† is almost equilateral, and is much higher in outline than *P. projectus*.

The shell from the Cretaceous of the east end of Maud Island (Queen Charlotte Islands), ascribed to *Camptonectes curvatus* Geinitz by Whiteaves,‡ is somewhat similar to *P. projectus*, to judge from the figure of a right valve, but it is more equilateral in form.

A *Pecten* from the Neocomian in German East Africa was described by G. Müller § under the name *P. striato-punctatus*, but the specimen figured is so preserved that a comparison with *P. projectus* is difficult, although it appears to differ from this in being more equilateral.

Pecten (*Camptonectes*) *pueyrrydonensis* Stanton,‖ from the Belgrano beds (Lower Cretaceous) of Patagonia is another shell of similar type, but differs at least in the more equilateral form of the right valve.

Pecten kamerunensis von Koenen,¶ from Lower Cretaceous strata in the Cameroons, differs from *P. projectus* by the more equilateral form and the rather coarser ornamentation, with stronger lateral rib-development. Von Koenen describes how the furrows appear here and there divided by swellings into little grooves, but says that this stands in connection with the crossing of lines of growth—a relation not to be observed in the minute ornamentation of *P. projectus*.

Sub-genus CHLAMYS J. F. Bolten.

Pecten (Chlamys) cf. subacutus Lamarck.

Plate II., figs. 6, 6*a*.

Cf. 1819. *Pecten subacutus* J. B. de Lamarck, Hist. Nat. des Anim. sans Vert., vol. vi., p. 181.

* Hennig (1), p. 41, pl. 2, figs. 28, 33.
† Zittel (2), p. 109, pl. xvii., fig. 8.
‡ Whiteaves (3), p. 242, pl. 32, fig. 4.
§ G. Müller (1), p. 550, Taf. 24, fig. 7.
‖ Stanton (3), p. 12, pl. iv., fig. 1.
¶ von Koenen (1), p. 20, Taf. iii., figs. 14, 15.

Cf. 1847. *Pecten subacutus* A. d'Orbigny, Paléont. Franç., Terr. Crét., vol. iii., p. 605, pl. 435, figs. 5–10.

„ 1872. *Pecten subacutus* H. B. Geinitz, Das Elbthalgeb. in Sachsen, part i., p. 195, pl. xliv., fig. 5 (Palæontographica, vol. xx.).

„ 1902. *Pecten (Chlamys) subacutus* H. Woods, Mon. Cret. Lamell. Engl., vol. i., part iv., p. 169, pl. xxxi., figs. 7–9. (Palæontographical Society.)

Descriptive Note.—A single specimen sent from the collection of the South African Museum seems to approach very closely to *P. subacutus.* The shell is ovate in outline, prolonged dorsally, with an acute apical angle (about 80°). The inflation is slight, with the left valve a little more convex than the right.

The valves are ornamented by about 22 strong, angular ribs with sharp summits. Near the inferior margin the summits of the ribs are separated from one another by a distance of about 2 mm. On parts of the shell the ribs are studded with numerous blunt, spinose projections. Where the surface is well preserved the ribs and interspaces are seen to be ornamented by very delicate, transverse linear markings, most clearly visible in the interspaces. Near the inferior margin these become obscurely developed and are masked by coarser ridges and grooves of accretion. The hinge-line and ears are unfortunately not preserved, but having regard to the other characters there is no reason to suppose that they differed essentially from those of *P. subacutus.*

Dimensions.—Height (about) 42 mm.; length 35 mm.

Occurrence.—Marine Beds of Sunday's River (304).

Remarks.—Pecten subacutus is characteristic of the Cenomanian in Europe, but this African shell approaches more closely to it than to any form from the Lower Cretaceous with which I am acquainted. In the imperfect material at disposal, no features are apparent which would justify a definite separation from the European form, yet in the absence of the ears in this specimen and the lack of further comparative material, the question of identity must remain open.

Pecten urgonensis de Loriol,* common in the Urgonian of Grand Salève, is a shell of very similar type, so far as can be judged from de Loriol's description and figures; but apparently its scaly ornaments are larger and more prominent, and the surface is perhaps more coarsely ribbed.

* de Loriol (2), p. 389, pl. C, figs. 25, 26.

Genus LIMA J. G. Bruguière.

Sub-genus ACESTA H. and A. Adams.

Lima (Acesta) obliquissima Tate.

Plate II., fig. 7.

1867. *Lima obliquissima* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 156, pl. ix., fig. 5.

Supplementary Descriptive Note.—The shell has great height in comparison with length. The posterior outline is gently rounded, the anterior profile straight. The straight anterior border passes at its lower end by a somewhat sudden curve into the rounded inferior border. The valves are most convex in the umbonal half and near the anterior side; they become flatter posteriorly and inferiorly. Anteriorly, the flank passes abruptly, though without marked carination, into an extensive, flat frontal face, truncating the shell. This frontal area is in no degree sunk or concave in form. The umbones are acute and sharp, terminal at the anterior extremity of the hinge-line; the superior border of the shell is straight and very short, and truncates the shell to form a right angle with the anterior border. The anterior ear is rudimentary or not developed; the posterior ear is much reduced, and not definitely demarcated from the flank.

The ornamentation consists of delicate linear radial grooves, very crowded near the umbo, gradually diverging until, at a distance of 40 mm. from the umbo, they may be separated by interspaces 2 mm. broad. At a distance exceeding 30 mm. from the umbo, these lines are almost or quite absent from the middle part of the flank, though well impressed on the lateral parts. The lines follow a more or less irregular and wavy course and are sometimes suddenly deflected to right or left when traced down from a prominent concentric growth-line. When well preserved, the linear ornaments show a minutely punctate structure, most perfectly developed in the umbonal half of an adult shell. The interspaces are very gently convex or are flat, but are without sculpture. On the frontal area the ornaments are of a more pronounced character, and may take the form of imbricating ridges with the edges directed away from the valve-margin. They radiate from the umbonal region and pass along the frontal face, gradually approaching the frontal valve-margin and forming an acute angle with this. On the frontal area, therefore, the ornaments are very obliquely crossed by the lines of accretion.

Dimensions.—

Greatest measurement radially from the umbo ...	64 mm.
Greatest length measurement, at right angles to the last	40 ,,
Greatest depth of a single valve	10 ,,

Occurrence.—Railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the line from Uitenhage to Graaff-Reinet, about three miles from Uitenhage (346); also stated to occur at Grass Ridge. Specimens in the collection of the Geological Society are labelled "Sunday River" (Rubidge) and "Zwartkop River" (H. Longlands). Tate's record of locality is "in a yellow shell-rock from the Zwartkop River sandstone, with *Placunopsis undulata* and fossil wood (Rubidge)." Fine specimens sent to me from the South African Museum are from the Sunday's River. Mr. Rogers obtained this form on the left side of the Coega Valley, half a mile down from the railway (455g).

Remarks.—Tate unhappily brought this shell into comparison with two British Jurassic forms, *L. rigidula* (Phill.) from the Cornbrash, and *L. ovalis* (J. Sow.) from the Great Oolite. *Lima rigidula** is of quite another type; it has a widely different outline, is comparatively coarsely ornamented, and has well-developed anterior and posterior ears. *L. ovalis*,† more oblique and anteriorly produced, with minutely delicate and crowded linear ornaments, can scarcely be brought into close comparison.

Lima obliquissima in reality may be most closely compared with those shells to which has been applied the sub-generic name *Acesta*,‡ represented in Cretaceous and later strata, and existing at the present day. The characters whereby this group of forms is distinguished from *Plagiostoma* and other divisions of the genus have been clearly set forth by E. Philippi in his analysis of *Lima*.§ Although I have as yet been unable to ascertain the position and form of the ligament pit in *L. obliquissima*, the close agreement in other features can leave little or no doubt that this shell must be united with *Acesta*, if this sub-generic group be adopted at all. These features are principally seen in the great relative height of the valve; the anteriorly little-produced outline; the anterior and terminal position of the umbones; the great reduction of the anterior ear and the imperfectly demarcated posterior ear. The fine linear

* Phillips (1), p. 116, pl. vii., fig. 13.

† J. Sowerby (1), tab. 114, fig. 3 (1815); Morris and Lycett (1), Part 2, p. 29, pl. iii., fig. 5.

‡ H. and A. Adams (1), p. 558.

§ E. Philippi (1), p. 630.

sculpture of the flank, it is true, recalls that of some *Plagiostomæ*, but the shell is in other respects strongly contrasted with that group. Concerning the value of the sub-generic name *Acesta*, particularly in the application to fossil forms, opinions have widely differed. It was accepted by Stoliczka* and by Zittel,† and latterly by Philippi, while regarded by Fischer as only representing a section of *Lima*.‡ This last author merely quotes the living type species, *L. excavata*. G. Boehm, however, has expressed the opinion that the sub-genus *Acesta* cannot be upheld,§ pointing out that the original diagnosis is inaccurate; that the name is unpractical in its application to fossil forms, in many of which the direction and position of the ligament pit, upon which the exact determination depends, cannot be investigated; and further, that the distinctive features of the proposed sub-genus are of slight importance. The first of these objections can have little weight, merely depending, as pointed out by Philippi, upon an original error of orientation. There is something to be said for the last point, perhaps, and it is clear that amongst fossil representatives of the genus there are some forms which illustrate in varying degrees the inequilateral character and the development of the anterior auricle. The name, however, though possibly not standing for a natural group, may for the present be conveniently employed to indicate the apparent affinities of the forms to which it is applied.

L. obliquissima shows a striking outward similarity to the typical living *Lima* (*Acesta*) *excavata* (Fabr.) Chemn.,|| though differing from this by the relatively more elongated outline, the shorter hinge-line, and the more restricted posterior cardinal expansion of the flank. A Neocomian shell having great resemblance in form to *L. obliquissima* is *Lima undata* (Desh.) Leym.,¶ but it is distinguished by its longer hinge-line and stronger ornaments. In the shortness of the superior margin and the character of the surface ornamentation, *Lima orbignyana* Math.** shows closer agreement, but it is distinguished from *L. obliquissima* by the more perfectly demarcated posterior ear, the concave outline behind this, the concave anterior area and the extension of linear ornaments over the whole flank. Matheron's figure shows a distinctly developed projecting anterior

* Stoliczka (2), pp. 413–415.

† Zittel (5), p. 26 (1881).

‡ Fischer (1), p. 941 (1886).

§ G. Boehm (1), p. 625.

|| E. Philippi (1), Taf. xxiv., fig. 5.

¶ Leymerie (2), p. 10, pl. 8, fig. 8; d'Orbigny (3), p. 528, pl. 414, figs. 9–12 (1847).

** Matheron (1), p. 182, pl. 29, figs. 3, 4

auricle, though this is represented as much more reduced in the figure given by d'Orbigny.

A *Lima* from the Lower Cretaceous of England, ascribed by W. Keeping* to Roemer's *L. longa*, shows great similarity in general form and outline. It differs, however, from the African shell by the relatively longer hinge-line and more extensive posterior ear, and although appearing to vary considerably in regard to the surface ornamentation, is characterised by a more pronounced type of radial sculpture; *L. longa* is further distinguished by the possession of great height measurement in proportion to its length.†

There is closer agreement, again, between *L. obliquissima* and *L. tenuitesta* Whitfield,‡ from Upper Cretaceous rocks in Syria. The two are practically identical in outline and the relative length of the superior border, but *L. tenuitesta* has the linear striæ of the surface more numerous and closely crowded at a given distance from the umbonal apex.

Sub-genus MANTELLUM J. F. Bolten.

Lima (Mantellum) neglecta Tate.

Plate II., figs. 8, 8*a*.

1867. *Lima neglecta* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 156, pl. vii., figs. 4*a*, 4*b*.

Three specimens, all left valves, are referable to this species. The ribs are acutely ridged, with sharp summits. The middle of the angular interspace is sometimes occupied by a fine linear ridge, and occasionally a second one may be present. These are stronger than the numerous, delicate, linear ridges which are developed on the sloping sides of the main ribs.

A specimen 20 mm. in length has a greatest diameter, measured at right angles to the length, of about 12 mm.

Occurrence.—On the left side of the Coega Valley, half a mile down from the railway (448g, 449g, 453g). The specimen described by Tate, numbered 11,013 in the collection of the Geological Society of London, came from the Sunday's River.

Remarks.—Tate's figure of this species is very inadequate, and does not give a good idea of the shell. The appearance of two sets

* Keeping (1), p. 112, pl. v., fig. 6.

† F. A. Roemer (1), p. 79, Taf. xiii., fig. 11 (1836); (2), p. 57 (1841). Since the above lines were written, Mr. H. Woods has published an account of this shell and considers that the Upware specimens were rightly identified with the German form: Woods (3), vol. ii., p. 25 (1904).

‡ Whitfield (1), p. 390, pl. iv.A, figs. 1, 2.

of ribs directed away from a dividing line, so clear a feature in the figure, is quite erroneous. In the specimen itself, an appearance of dichotomy occurs only in one rib, and this seems to be due to an accident of preservation. There is a crack in the shell, and a portion of the valve on one side has become pushed slightly over the surface on the other side of the crack. From an examination of the specimen it is difficult to say with certainty whether this injury took place during the life of the animal, or subsequently, but the resulting irregularity in the sculpture was in any case not a normal character.

There is a close general resemblance between *L.* (*Mantellum*) *neglecta* and *L. parallela* J. de C. Sow.; * but in *Lima neglecta* the oblique elongation is greater and the posterior ribs are more crowded and delicate. *Lima* (*Mantellum*) *gaultina* Woods † is more closely similar to *L. neglecta* in outline, but its antero-ventral border is more narrowed, and the fine linear rib in the interspace between the main ribs is lacking.

Genus PERNA J. G. Bruguière.

Perna atherstoni Sharpe.

Plate II., fig. 9.

1856. *Perna atherstoni* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 193, pl. xxii., figs. 4, 4*a*.

Occurrence.—This shell was found at Dunbrodie (Sunday's River), in the cliff below the old school-house (282, 305, 320), and at Walton's Farm, below Dunbrodie (311). It was recorded by Sharpe from the same place (Geelhoutboom) "in greenish grit with fragmentary shells."

Remarks.—These specimens from Dunbrodie were thought to represent very probably a new form, but a comparison with Sharpe's original specimens of *P. atherstoni* shows that they differ from these in no essential particular. One of the Dunbrodie individuals, it is true, shows a slight difference in outline; its antero-inferior border, at a distance of 15 mm. from the umbonal apex, has a broad indentation or inward curve in profile, somewhat more strongly developed than in the original of Sharpe's figure 4. Other specimens which I have examined exhibit this feature in less degree, and it appears to be a character which is subject to some individual

* For full description and references to literature see Woods (3), vol. ii., part 1, p. 28, pl. v., figs. 14, 15 (1904).

† Woods (3), vol. ii., part 1, p. 31, pl. v., figs. 16–20 (1904).

variation. The convex fold of the valve, passing back from the umbo, is marked off from a small, flattened, marginal portion of the valve between the fold and the antero-inferior margin near the umbonal end, in clearer manner as a rule than is depicted in Sharpe's figure. In this respect the figure is misleading, for the fold is well developed in the original specimen. In another point, also, the illustration leaves something to be desired; the postero-inferior border, restored by a dotted line, should in reality have been represented as a rounded curve similar to that followed by the outline of the same part in *Perna mytiloides* Lam., and should not have been drawn in the angular or sub-angular form which lends such a false aspect to the outline of the shell as depicted in Sharpe's work.

P. atherstoni is characterised by its oblique figure and the relatively great length of the hinge-line. In these features it recalls *P. mytiloides* Lam., from the Upper Oolites of England,* which in general aspect it much resembles; but in *P. atherstoni* the shell is less sharply pointed and produced at the umbo, is less inflated anteriorly, and is more obliquely elongated. There are further points of difference which it is unnecessary to recount.

Genus PINNA Linnæus.

Pinna atherstoni Sharpe.

1856. *Pinna atherstoni* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 193, pl. xxii., fig. 1.

Occurrence.—Railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the railway from Uitenhage to Graaff-Reinet, about three miles from Uitenhage (329, 330), where it is very abundant in a bed of nodular limestone.

Remarks.—It has been noted by Messrs. Rogers and Schwarz that this shell, associated with *Holcostephanus atherstoni*, marks the most constantly recognisable zone in the Marine Beds of the Zwartkop's River valley.

Pinna atherstoni was compared by Sharpe and Tate with *P. hartmanni* Zieten, from the Lias of Europe, and it certainly agrees more closely with *P. hartmanni*, as figured by Goldfuss,† than with the generality of Cretaceous forms, most of which are more elongated and slender in outline. The original figure given by Zieten ‡

* Damon (1), pl. ii., fig. 5.

† Goldfuss (1), Band ii., p. 164, Tab. cxxvii., fig. 3*b* (1837).

‡ Zieten (1), p. 73, Tab. 55, fig. 5 (1833).

has, however, a very different aspect from that of Goldfuss; it apparently has a narrower apical angle, and the surface ornaments are so delineated as to be scarcely comparable with those of *P. atherstoni*. The resemblance of *P. atherstoni* to the Liassic form usually known by Zieten's name is clearly a fact of no importance in the question of the age of the Uitenhage fauna. It may be noted that a specimen of *Pinna* from the *Perna*-bed of Atherfield, Isle of Wight, preserved in the Sedgwick Museum at Cambridge, has form and proportions closely similar to those of *P. atherstoni*. The specimen is unfortunately ill-preserved and unfitted for a detailed comparison. A similarly broad form has also been recorded from the Buda Limestone, the upper part of the Lower Cretaceous series of Texas.*

Genus OSTREA Linnæus.

Ostrea sp.

Specimens of *Ostrea* (305, 306, 336) which occur in the cliff below the old school-house at Dunbrodie (right bank of Sunday's River), in association with *Perna atherstoni*, *Pecten cottaldinus* and *Gastrochæna dominicalis*, are in a very poor state of preservation and consist chiefly of fragments. Valves of flattened form measure upwards of 40 mm. from the umbo to the opposite border and about 30 mm. from margin to margin in a direction perpendicular to this. The outline of the valve becomes broadly pointed at the umbonal end. Other imperfect individuals are represented by valves of smaller dimensions, and these appear to be less elongated and more convex. None of the valves suffices for specific determination, but it is probable that two forms are represented.

Genus EXOGYRA T. Say.

Exogyra imbricata Krauss.

1843. *Exogyra imbricata* F. Krauss, Amtlicher Bericht über die zwanzigste Versammlung der Gesellsch. deutsch. Naturforscher und Aerzte zu Mainz im Sept., 1842, p. 129.

1850. *Exogyra imbricata* F. Krauss, Nov. Act. Acad. Cæs. Leop.-Carol. Nat. Cur., vol. xxii., pt. 2, p. 460, Tab. 50, figs. 2*a*–2*d*.

1856. *Gryphæa imbricata* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 197, pl. xxiii., figs. 3*a*, 3*b*.

* Shattuck (1), p. 19, pl. vii.

1867. *Ostrea imbricata* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 154.

1904. *Pycnodonta imbricata* H. Douvillé, Bull. Soc. Géol. France, ser. 4, tome iv., p. 215.

Occurrence.—This form is widely and abundantly distributed in the Marine Beds of the Zwartkop's, Sunday's, and Coega River valleys. It was met with at almost all the exposures in the Zwartkop's valley visited by Messrs. Rogers and Schwarz. Examples sent to me are from the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the railway from Uitenhage to Graaff-Reinet (312), and others were collected by Miss M. Wilman at Coega. Specimens sent from the collection of the South African Museum are from the Sunday's River (300, 301, 302, 303).

Remarks.—A striking character of the late adult and senile condition of *E. imbricata* consists in the prodigal manner in which shell substance is added at the margins of the valves, particularly noticeable in the smaller (right) valve in the neighbourhood of the hinge. Here, with its margin consisting of many coarse, imbricating laminæ, this valve may attain a thickness exceeding 30 mm. The ligament pit is seen to be strongly curved near the apex, but straight in the portion representing the later growth-stages.

This abundant and characteristic shell has given rise to some differences of opinion concerning its generic position within the Ostreidæ, which, however, may be sufficiently accounted for by the great variability of form exhibited by different individuals, and by the fact that the shell presents features which are recognised as leading characteristics of both *Exogyra* and *Gryphæa*. For this reason Tate used the name *Ostrea* in the broad sense, stating his opinion that the species in question "affords a good illustration of the mere sectional value (which cannot at all times be employed) of the groups *Exogyra* and *Gryphæa*." In many instances, it must be admitted, apparent passage forms seem to render difficult the definite separation of the three genera, so easily distinguishable when represented in their more characteristic aspects.* Jackson has made some luminous observations on the relation of these three genera and on the influence of the character of attachment by cementation in producing modifications in members of the Ostreidæ.† He believes that *Gryphæa* and *Exogyra* "are probably aberrant members of the Ostreidæ, not typical forms in the line of evolution of the group."

* Leymerie (1*a*). See also Peron's remarks on these genera, Peron (1), pp. 107–9.

† Jackson (1), sections v. and vii.

It is highly probable that the shells classed as *Gryphæa* do not represent a homogenetic group, but are polyphyletic in origin, including repeated offshoots from an ostrean stock. While, in the progress from *Ostrea* to *Gryphæa*, there is diminished duration of the attached habit, so that the typical *Gryphæa* is fixed by cementation of the left valve only during the young stage, examples are not wanting in which the highly specialised characters of *Gryphæa* are seen to become modified by the acquirement once again of more prolonged attachment. As an instance of this, reference may be made to the shells which, at the close of the deposition of the Oxford clay in England, seem to have largely replaced the familiar *Gryphæa dilatata* J. Sow. In these modified forms, the attached valve did not become free until the neanic stage had been completed or the adult stage had been well entered upon, and the shell therefore perforce retained a relatively flatter and more ostreiform aspect.* *Exogyra imbricata* might be thought, on cursory examination, to bear no slight analogy to these: the area of attachment has very frequently a similar relation, in point of dimensions, to the whole fully-grown valve, and it is only on the cessation of attachment that the individual acquires the manner of growth of a *Gryphæa* and develops the arcuate form which led Sharpe to institute comparison with Liassic shells. It must be realised, however, that in this African form we have an illustration of the passage from a more complete to a less persistent duration of attachment, in the life of the individual, for a study of the youthful stage shows beyond doubt the exogyrate ancestry, and this may be clearly seen in many specimens in which the nature of the youthful characters did not become masked by the modifications incidental to fixation. The duration of attachment varied very much in different individuals, and no doubt often depended upon the nature and form of the object to which the young shell adhered. In some cases a relatively large area of attachment may retain the impress of some foreign surface, such as that of the large and coarsely ribbed *Cucullæa kraussi* Tate, or a pseudo-quadrate *Trigonia*, in a manner which largely obscures the true nature of the umbonal region. Other individuals, again, seem to have secured themselves to some less suitable or stable surface, and at an earlier stage to have entered upon the period of freedom. In these, as in some which have been attached to an even surface, the characters of the fixed stages are clearly seen to be those of a true *Exogyra*, and present the strongest contrast to

* Compare also figure of *Gryphæa alligata* from the Corallian of Nattheim Quenstedt (1), p. 752, Tab. 91, fig. 25 (1857).

the features of the nepionic and neanic stages of *Gryphæa* as illustrated, for instance, in the admirable descriptions and figures given by Hill and Vaughan of members of the genus occurring in the Lower Cretaceous strata of Texas.* When we see how closely the manner of growth in the adult stage of *E. imbricata* often simulates that of a true *Gryphæa* with simple ostrean ancestry, it must be admitted that the parallelism is very striking.

It would be difficult to indicate within narrow limits the true relationship of *Exogyra imbricata*, but it is evident that its nearest morphic counterparts are essentially characteristic of Lower Cretaceous rocks. Thus, a very close resemblance exists between this form and some of the shells classed by Leymerie under the name *Exogyra sinuata* and *E. subsinuata*. Leymerie first regarded all these as varieties of *Exogyra sinuata*,† and included forms to which numerous specific names had previously been applied. He subsequently separated *E. subsinuata* as a species distinct from *E. sinuata*, and used several varietal designations of both. Regarding the value of the nomenclature employed by this author or by Coquand‡ in dealing with the forms comprised within this perplexing group, I am at present unable to attempt the critical and detailed study which alone would warrant the expression of any judgment; in like manner, the varying use of the name *Exogyra couloni* by different authors has given rise to such a degree of confusion that, in instituting comparisons, it must suffice to make reference to actual figures or descriptions, leaving aside for the time being all question of the value or correctness of the specific names attached to certain of these.

Krauss rightly recognised the broad relationships of *E. imbricata* and believed it to be nearly related to "*Gryphæa couloni* Defr.," from which, however, he found it to differ in the following points: "It is larger, more thick-shelled, longer and narrower; has a keel narrower at the end (though always rounded), more concave laminæ lying much higher one upon the other, and a stronger umbo bent further over the opercular valve, than in *Gryphæa couloni* Defr." Some of the shells figured by d'Orbigny as *Ostrea couloni* § show no slight resemblance to selected individuals of *E. imbricata*, but are narrower than the generality of the Uitenhage specimens, and the imbricating lamellæ of the larger valve are more prominent and irregular. The broad, plicated specimens figured by d'Orbigny under the same name on plate 466 of his work cannot be brought

* Hill and Vaughan (1).

† Leymerie (1).

‡ Coquand (2).

§ d'Orbigny (3), pl. 467, figs. 1–3 (1848).

into comparison. The shells figured by Coquand * as *Ostrea couloni* include narrow forms, more elongated and more decidedly carinated than *E. imbricata*, as well as a broad type, developing plications of the larger valve in the later adult stage, which is in no respect closely comparable with the form we are considering.

Sowerby's *Exogyra sinuata*,† though itself very variable, is typically widely separated from *E. imbricata* by the strong carination of the larger valve and the widely expanding form of this, with the much less arcuate habit of growth and the considerably greater adult dimensions. Some French forms figured by Leymerie and brought into relationship with Sowerby's species, though perhaps erroneously, afford, on the other hand, material for a close comparison with *E. imbricata*. Thus, Leymerie's *E. sinuata*, var. *elongata* ‡ can be fairly closely matched, while extreme individuals of *E. imbricata*, in their narrow outline and very arcuate growth, nearly resemble that author's figure of *E. subsinuata*, var. *aquilina*.§ The shell from the Neocomian of the Haute-Marne figured by Bayle || as *Actostreon aquilinum* (Leym.), again, closely resembles very narrow and curved specimens of the African form.

Ostrea tardensis Stanton,¶ from the Lower Cretaceous Gio beds of Patagonia, may, in selected individuals, somewhat closely approach *E. imbricata*, but its near relationship to this must be considered doubtful; it seems, however, to represent in some respects an analogous type. The exogyrate character of the umbonal region is only feebly indicated, according to Dr. Stanton, who says that the "lower valve is very thick and very convex, obscurely carinate, with the beak more or less twisted laterally, but not distinctly coiled." It differs also by frequently acquiring a marked crescentic form in the adult. If the Patagonian shell had a true exogyrate ancestry, which appears probable, the early characters seem to have so far disappeared as to indicate that relationship to *E. imbricata* is probably somewhat remote.

The shell from the Neocomian of Arqueros in Chili described by Bayle and Coquand as *Ostrea couloni*,** and afterwards brought into association with a heterogeneous company under the collective name

* Coquand (2), p. 180, pl. 65, fig. 10; pl. 71, figs. 8–10; pl. 74, figs. 1–5; pl. 75, figs. 1–6, 22.

† J. Sowerby (1), vol. iv., Tab. 336 (1822). [As *Gryphæa*.]

‡ Leymerie (2), p. 17, pl. 12, fig. 2.

§ Ibid., pl. 12, figs. 6, 7.

|| Bayle (1), pl. cxl., figs. 3–5.

¶ Stanton (3), p. 11, pl. i., figs. 1, 2; pl. ii., figs. 1, 2.

** Bayle and Coquand (1), p. 37, pl. vii., figs. 1, 2.

"*Ostrea aquilina*" by Coquand,* closely resembles many specimens of *E. imbricata* in the form and inflation of the valves and in the degree of curvature of the umbonal region; but it differs by the more marked carination of the larger valve. Remes has considered both the Chilian shell and *Exogyra imbricata* Krauss to be identical with Sowerby's *Exogyra sinuata*,† but this is certainly an error. The same author, however, has figured an *Exogyra* from Stramberg,‡ ascribed by him to *Exogyra subsinuata* Leym., to which selected individuals of *E. imbricata*, in which the surface of attachment is relatively large, may show considerable resemblance.

An exogyrate shell from the Bajocian of Abyssinia was ascribed by Douvillé § to *E. imbricata* Krauss, but this was an erroneous identification, as already pointed out by G. Müller.|| The resemblance of the small specimens figured by Douvillé to selected young individuals of *E. imbricata* is indeed not a distant one, but many of the Uitenhage specimens are attached by a very much larger surface, and, moreover, attain a colossal size in comparison with Douvillé's types, if these represent the adult stage. The variation in *E. imbricata* is so great that a more detailed and critical comparison could not be entered upon without a substantial suite of specimens of the Abyssinian shell.

A shell from the Isakondry basin in Madagascar (presumably from strata of Lower Cretaceous age) is stated by Douvillé to bear a close resemblance to *Exogyra imbricata* Krauss.¶

Genus MYTILUS Linnæus.

Mytilus uitenhagensis sp. nov.

Plate II., figs. 10, 11, 11*a*.

Description.—The shell is slender and elongated in outline, sharply pointed in front, and antero-ventrally truncated. The hinge-margin is straight, and passes backwardly by a curve into the obliquely sloping posterior margin, which is only very slightly convex in outline until the posterior end of the valve is reached. In profile, the antero-ventral margin is straight, passing from the acutely pointed umbo to the posterior angle of the valve, where it abruptly cuts the curved outline of the posterior margin.

The antero-ventral area is flat, and its surface is perpendicular

* Coquand (2), p. 158.

† Remes (1), p. 216.

‡ Remes (1), pl. xxi. (iv.), figs. 2*a*, 2*b*.

§ Douvillé (1), p. 230, pl. xii., figs. 8, 9.

|| G. Müller (1), pp. 569, 570.

¶ Douvillé (2), p. 388; Douvillé (4), p. 215; Lemoine (1), p. 176.

to the plane of symmetry of the valves. The junction of this portion of each valve with the very gently convex upper portion is acutely angular, giving rise to a sharp carinal ridge which, however, becomes very slightly blunted towards the posterior end of the valve.

The shell is devoid of sculpture, but its smooth upper surface is marked by numerous delicate growth-lines which form a sweeping curve between the hinge-margin and the carinal ridge. The antero-ventral area is sometimes marked by coarser, rounded, obliquely running ridges of accretion. Traces of the narrow, elongated, fossilised ligament have been observed.

Dimensions.—

Length of the antero-ventral margin .... 37 mm.
Length of the cardinal margin.. 16 „
Greatest breadth of flank between the carinal ridge and the posterior valve-margin .... 13 „
Greatest width of the antero-ventral area in one valve ...... 7 „

Occurrence.—Found at Dunbrodie, Sunday's River (319). Specimens collected by Atherstone and preserved in the British Museum (Natural History) are labelled "Cuylers." Also collected by Mr. Rogers from the lowest beds on Zoet Geneugd, right bank of Sunday's River (64h), and in the Coega Valley, one mile up the line from Coega station (479g).

Remarks.—This is doubtless the form noticed by Krauss * in the lowest fossil-bearing beds on the left bank of the Zwartkop's River below Uitenhage, in association with *Trigonia herzogi*, *T. conocardiiformis*, and *T. ventricosa*. Krauss speaks of a *Mytilus* "with a sharp ridge running from the umbo to the hinder extremity and a flat truncated surface extending from this ridge to the ventral margin." The shell was capable of attaining dimensions exceeding those of the larger specimen figured here. A specimen in the Geological Society's collection, incomplete at the posterior end, must have originally measured 50 mm. in length; the maximum breadth of its flat area is 11 mm. in each valve. Two imperfect large valves now preserved in the British Museum (Nat. Hist.), which form part of a collection at one time placed in the Museum of Practical Geology, probably had a length of fully 45 mm. when complete. The antero-ventral area measures about 9 mm. in breadth in one of these, while the greatest breadth of the flank, measured by a line perpendicular to the carinal margin, is 18 mm. The area is perfectly flat and the carinal ridge acutely sharp.

In the absence of knowledge regarding the interior of the shell,

* Krauss (2), p. 443.

this form can at present only be looked upon as a representative of the genus *Mytilus*. No doubt, indeed, concerning its generic position could have been reasonably suggested, had not a detailed study of the externally very similar *Mytilus lanceolatus* J. de C. Sowerby, led Mr. H. Woods to ascribe that shell to the genus *Dreissensia*,* a determination which was based upon the presence of an umbonal septum. A strong case was made out by Mr. Woods for the existence of marine forerunners of the modern *Dreissensia*, an inhabitant of brackish and fresh waters, and he was also supported by the opinion of M. Cossmann, who has found the genus to be associated with marine forms in the Upper Eocene of the Paris basin. In view of close external similarity to *Driessensia lanceolata* it would not be surprising if the shell here described were eventually also shown to be furnished with an umbonal plate, but until this can be proved it will be necessary to retain the name *Mytilus*.

Compared with *Dreissensia lanceolata* (= *Mytilus lanceolatus* J. de C. Sow.)† from the Lower Greensand and Upper Greensand and Blackdown Beds of England, *M. uitenhagensis* is seen to agree closely in general form, but to be distinguished by several points of detail. In the African shell the antero-ventral area is flat throughout its extent, which is not the case in the European form; in *M. uitenhagensis* the carinal ridge is more sharply acute in the umbonal region than in many examples of *D. lanceolata*. Further distinguishing features possessed by *M. uitenhagensis* are the relatively slightly shorter hinge-line, the less steeply sloping outline of the posterior margin, the relative narrowness of the flank between the carinal ridge and the posterior margin, and the absence of concentric ornaments at any stage of growth. The shell from the Cretaceous of Shingle Bay, Skidegate Inlet (Queen Charlotte Islands), described by Whiteaves under the name *Mytilus lanceolatus*,‡ may or may not be identical with the European form. To judge from the description and figures, it shows considerable similarity to *M. uitenhagensis*, though appearing to differ by the imperceptible passage of the hinge-border into the posterior border, the curved outline of the carinal margin, and the concavity of the antero-ventral area.

Several forms described from the Senonian Greensand of Aachen

* Woods (3), vol. i., p. 110 (1900).

† J. de C. Sowerby (1), vol. v., p. 55, Tab. 439, fig. 2 (1823); H. Woods (3), vol. i., p. 110, pl. xviii., figs. 13–15, pl. xix., figs, 1–11 (1900).

‡ Whiteaves (3), p. 236, pl. 31, figs. 7, 7*a*.

by J. Müller,* and united by Holzapfel † under the name *Septifer tegulatus*, may possibly be identical with Sowerby's *M. lanceolatus*, according to the view of Prof. Holzapfel and Mr. H. Woods. While the points of difference from *M. uitenhagensis* are in the main those noted above in the case of the English shell, the specimens from Aachen dealt with by Prof. Holzapfel appear to be still more strongly distinguished by their frequently curved antero-ventral margin and their well-marked concentric ornament.

In *Mytilus tornacensis* d'Archiac,‡ from the Tourtia of Tournay, the hinge-line is relatively longer than in *M. uitenhagensis*, while the antero-ventral area is not flat and the carina is much less sharp; there are also markings on the shell at right angles to the lines of growth.

A form bearing greater similarity to *M. uitenhagensis* is *Mytilus triangularis* J. Böhm,§ from the *Trigonia*-sandstone of Lebanon.|| This has a similar elongated outline, sharp carinal ridge and flattened antero-ventral area; but it is apparently well distinguished by the manner in which the hinge-margin and posterior margin pass imperceptibly by a curve into one another when viewed in profile. In *M. triangularis*, too, the flank between the carina and the posterior margin is slightly narrower, while Dr. Böhm's figure 11*b* represents the outline of the carina as somewhat curved.

In order to illustrate how great a sameness of characters may persist or recur in mytiloid shells, it is only necessary to refer to such a form as *M. aviothensis* Buv.¶ from the Lias of Avioth, Breux. This closely resembles *M. triangularis*, from the Syrian Cretaceous, in most outward characters, and differs from *M. uitenhagensis* chiefly in those points which distinguish *M. triangularis* also, though exhibiting a slight convexity of the antero-ventral area not developed in these Cretaceous forms.

Genus MODIOLA Lamarck.

Modiola baini Sharpe.

Plate II., figs. 12, 12*a*.

1856. *Modiola bainii* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 193, pl. xxii., figs. 2, 3.

Supplementary Descriptive Note.—As an addition to Sharpe's description, it may be noted that the oblique lateral "keel" is only

* J. Müller (1), p. 35. † Holzapfel (1), p. 218, Taf. xxv., figs. 1–9.

‡ d'Archiac (1), p. 307, pl. xv., fig. 3. § J. Böhm (2), p. 218, Taf. vii., fig. 11.

|| For remarks on the age of this sandstone see Rehbinder (1), p. 87.

¶ Buvignier (1), p. 24, pl. xvi., figs. 35–37.

developed as a rounded folding of the valve. Above this the surface is evenly convex, while below it the valve is flattened. An uncrushed specimen therefore shows in transverse section an outline different from that depicted by Sharpe in his figure 3*b*. It is true that the upper portion of the valve also becomes much flattened in the posterior part of an adult specimen, but only near the siphonal margin. The ribs, starting above at the valve-margin, are directed obliquely backwards, and before the lateral fold is reached they bifurcate, at the same time curving sharply with the convexity backwardly directed. An occasional extra, curved rib is here intercalated. Just below the lateral fold the ribs unite again in twos or threes and pass forward in the form of a number of fine, unequally spaced ridges which occupy the lower flattened portion of the valve and run roughly parallel to one another and to the lower margin. In addition to these ridges, the valve below the oblique lateral fold is ornamented by a series of very numerous and crowded, delicate, vertically running raised stripes or wrinkles. This vertical wrinkling is very regular, and occupies the whole of the surface below the lateral fold, crossing the horizontal ridges at right angles. The wrinkles, which number upwards of forty within a space of 10 mm., are developed both on the ridges and interspaces.

Occurrence.—Collected in the Zwartkop's River valley, one mile north-east of Rawson Bridge (281). Recorded by Sharpe from the Sunday's River at "C. Roe's drift," and by Stow from above Modder Drift and from M'Loughlin's Bluff, on Sunday's River.

Remarks.—The specimens figured by Sharpe, in the collection of the Geological Society, show the vertical wrinklings on the lower portion of the valve, though no mention was made of these. Well-preserved specimens exhibit these structures very clearly, and show that they form a definite part of the sculpture.

The group to which this shell belongs is more characteristic of Jurassic than of Cretaceous rocks. *M. sowerbiana* (d'Orbigny) (=*M. plicata* Sow.),* a typical Oolitic form, has a much more numerous division of the ribs above the lateral fold, and is rather more curved in outline. *M. perplicata* (Etallon),† from the Upper Jurassic of Europe, is similar in the bifurcation of its ribs; but it attains a greater height in relation to length, and has also a more curved outline. The descriptions and figures of *M. perplicata* ‡

* d'Orbigny (4), vol. i., pp. 282, 312; J. Sowerby (1), vol. iii., Tab. 248, fig. 1 (1819).

† Thurmann and Etallon (1), p. 223, pl. xxix., fig. 8 (1862); Loriol and Pellat (2), p. 156 (312), pl. xviii., figs. 19, 20.

‡ See also Loriol, Royer, and Tombeck (1), p. 348, pl. xix., figs. 10, 11.

make it clear that the vertical striping on the lower part of the flank is developed in that form also; the same occurs in *M. medus* (d'Orbigny), an allied shell from the Kimeridge.

A shell of very similar type to *M. baini* is *M. flagellifera* (Forbes),* from the Upper Cretaceous of Europe and Southern India; but an examination of the type specimens in the Geological Society's collection shows that these have the ribs dividing chiefly into groups of three, and the lower part of the flank entirely lacks any traces of the fine vertical stripes.

A fragment of a similarly ornamented, elongated *Modiola* from the Cenomanian of the Sarthe, was considered by d'Orbigny to be specifically distinct from others previously described, and was figured by Guéranger † as *Mytilus sarthensis.* It may be clearly seen from that author's photographic illustration that this differs from *M. baini* by the relatively greater disparity in the number of large and small ribs; in the French shell there are three small ribs to each of the major ribs.

Modiola rubidgei (Tate), ‡ from the Uitenhage Marine Beds, also bears a general resemblance to *M. baini.* In *M. rubidgei*, however, the ornaments on the upper part of the valve consist of relatively few, gently rounded folds in place of the well-defined narrow rounded ribs in *M. baini;* in addition, these folds are themselves ornamented by finer linear markings which pass backwards along them and then curve forward to run parallel to the lower margin. In *M. rubidgei* there is also an absence of vertical striping on the lower part of the valve.

Genus NUCULA Lamarck.

Nucula uitenhagensis sp. nov.

Plate II., fig. 13.

Description of a Single Specimen.—The shell is oval in outline, short and high posteriorly, moderately inflated. The cardinal margin slopes down forwards from the umbo with a gently convex outline, and passes by a curve into the rather short anterior margin. The posterior margin falls steeply from the umbo and passes by a rather sharp curve into the long, gently convex inferior margin. The greatest height is at the umbo. The umbonal region is rounded and broad, and not strongly prominent. From the umbo a very faintly developed, blunt ridge of the valve-surface passes forward,

* Forbes (2), p. 152, pl. xvi., fig. 9; Woods (3), vol. i., p. 99, pl. xvii., figs. 1, 2 (1900).

† Guéranger (1), p. 17, pl. xxiii., fig. 1. ‡ Tate (1), p. 157, pl. ix., fig. 11.

cutting off a narrow, flattened, or slightly concave area contiguous with the cardinal margin. The greatest inflation occurs at about the middle of the valve.

The surface bears numerous closely spaced, delicate, raised, concentric linear ornaments, very weakly developed and indistinct in the umbonal part of the shell, more strongly developed in the inferior half of the valve. These linear ornaments are not produced with perfect regularity, but show occasional inequalities in their spacing, and an occasional coalescence of adjacent lines may be observed, particularly in the posterior part of the valve.

Dimensions.—

Length	17 mm.
Greatest height	11 ,,
Greatest depth of a single valve	5 ,,

Occurrence.—Found by Mr. Rogers in a wash-out 100 feet above Coega station, at a point one mile north of Coega Hotel (441g).

Remarks.—The specimen described has both valves in position, and is perfect except posteriorly. When the above description was written the right valve was quite perfect, though the lunular region (in this genus posterior to the umbo) was somewhat obscured by very hard matrix, but an attempt to remove this resulted in slight injury to the valve at the posterior border, so that the margin there is now not quite perfect. Unfortunately a single specimen only was obtained, but it seems to be sufficiently well preserved and well characterised to support the establishment of a new species.

The shell is distinguished by its oval form and rounded, soft outlines. In these respects it bears a considerable resemblance to *Nucula obtusa* J. de C. Sow., from the Upper Greensand and Blackdown Beds of England.*

Genus GRAMMATODON F. B. Meek and F. V. Hayden.

Grammatodon jonesi (Tate).

Plate II., figs. 14, 14*a*.

1867. *Arca* (*Cucullæa?*) *jonesi* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 161, pl. ix., fig. 9.

Occurrence.—Collected by Miss M. Wilman at Coega. This shell is also recorded by Messrs. Rogers and Schwarz as occurring in the highest of three beds of sandstone on the Grass Ridge road near Uitenhage.† The specimens described by Tate occurred "in a

* Woods (3), vol. i., p. 22, pl. iv., figs. 2, 3, 4 (1899).

† Rogers and Schwarz (1), p. 9.

greenish-grey sandy marl, rather hard and very calcareous, near the Bridge on the Zwartkop River."

Dimensions.—	(1)	(2)	(3)	(4)
Length	13	18	21	22 mm.
Height	9	12	14	13 ,,
Depth of a single valve	4	—	6	— ,,

No. (2) is Tate's figured specimen.

Remarks.—This form is closely similar in general type to *G. securis* (Leym.) * (Lower Cretaceous) and *G. carinatus* (Sow.) † (Gault and Upper Greensand), and although I have been unable to ascertain the characters of the hinge, the close agreement in form and ornamentation is perhaps sufficient justification for classing this shell in the same generic group of the Arcidæ. In the use of the name *Grammatodon* I follow Mr. Woods.‡

Compared with *G. securis*, our shell is found to differ by the considerably finer and more closely spaced ribs on the flank of the left valve. With regard to the ribbing, there is greater similarity to *G. carinatus*, but this, on the whole, is a decidedly more equilateral shell, although specimens might be selected which in most respects closely approach *G. jonesi*. *G. carinatus* frequently attains much larger dimensions, with a proportionately coarser development of the ornaments, than *G. jonesi*. A shell of similar type, and perhaps related to *G. jonesi*, occurs in the Lower Neocomian beds of German East Africa, which were correlated by G. Müller with the Uitenhage Series. Müller described and figured this under the name *Arca uitenhagensis*,§ and drew attention to the apparent relationship to *Arca jonesi* Tate. *A. uitenhagensis*, which is associated with *Trigonia ventricosa* (Krauss) and *T. beyschlagi* Müller, differs from *Grammatodon jonesi* by the fewer number and much greater breadth of its ribs.

Genus UNIO A. J. Retzius.

Unio uitenhagensis sp. nov.

Plate II., figs. 15, 15*a*.

Description.—The shell is of elongated oval outline, posteriorly produced, and laterally compressed in the postero-inferior region of

* Leymerie (2), p. 6, pl. vii., figs. 6, 7; Woods (3), vol. i., part 1, p. 44, pl. vii., figs. 14, 15, pl. viii., figs. 1, 2 (1899).

† J. Sowerby (1), vol. i., p. 96, Tab. 44, lower figure (1813); Woods (3), vol. i., p. 45, pl. viii., figs. 3–8 (1899).

‡ Woods (2).

§ G. Müller (1), p. 542, pl. xxv., fig. 5. [This name seems very unhappily chosen.]

the adult. The umbones are situated at almost one-third of the shell's total length from the anterior extremity. The umbonal region is relatively very inconspicuous, and of blunt, rounded form. The shell-substance is for the most part very thick, but becomes attenuated at the pallial margin. The upper margin in front of the umbo passes by a curve into the rather short, convex anterior border. The posterior margin merges into the upper margin and slopes obliquely back, to pass by an abrupt curve into the inferior margin.

The greatest height is at the umbo, and the greatest inflation, which is relatively weak, occurs below the umbonal region, in the superior half of an adult individual. About the middle of the shell near the pallial margin the valves appear slightly constricted, as though laterally pinched in. The surface is marked by numerous noticeable furrows and ridges of accretion.

Dimensions.—	(1)		(2)
Greatest length	37	.	43 mm.
Greatest height	21	.	23 ,,
Greatest depth of a single valve	7	.	8 ,,

Occurrence.—In a hard calcareous band in the rocks of Atherstone's "Wood Bed" series, on the north bank of the Bezuidenhout's River below Blue Cliff station (322, 323).

Remarks.—The shells still retain traces of the strong periostracum, and the elongated external ligament is also in part preserved. This is apparently the form cited by Messrs. Rogers and Schwarz as *Psammobia*,* and such a generic determination might appear to receive some support from the elongated oval figure of the shell, the inconspicuous umbones, the relatively compressed aspect of the valves, and the lengthened external ligament. The valves, however, are very thick, and this character, as well as the wrinkled surface and the blunt and obviously corroded umbones, proclaims another generic position; moreover, the pallial line is entire. In the shell-structure, also, although this has become obliterated in its intimate characters through replacement by calcite, it can be clearly observed that a line of demarcation separates a thin outer layer, representing the original prismatic layer, from the relatively thick inner portion, formerly consisting of nacreous substance.

This form differs from *Unio porrectus* J. de C. Sow.,† from the Wealden, by the less strongly elongated outline and the much less tapering posterior extremity. *Unio antiquus* J. de C. Sow.

* Rogers and Schwarz (1), p. 13.

† J. de C. Sowerby (1), vol. vi., Tab. 594, fig. 1 (1828).

(Wealden) * is rather less equilateral, the umbonal region is more prominent, and the antero-superior border more steeply sloping.

Unio martini J. de C. Sow. (Wealden) † is more equilateral, much higher and less slender in figure, and probably a more inflated form.

Unio subsinuata Koch and Dunker,‡ from the Wealden of North Germany, is in some respects similar, notably in the form of the posterior half of the shell and the position of the umbones, but differs markedly in the horizontally produced superior margin in front of the umbones. *Unio voltzi* Koch and Dunker,§ though regarded by those authors as distinct from the last, differs in similar manner from *Unio uitenhagensis*. *Unio planus* Roem.‖ is more compressed in form and has a less sloping antero-superior outline.

A comparison with the figures and descriptions of the forms of *Unio* from the Jurassic and Cretaceous rocks of North America does not show that resemblances exist which call for special remark.

Genus TRIGONIA J. G. Bruguière.

Trigonia ventricosa (Krauss).

Plate III., figs. 1, 1*a*.

1843. *Lyriodon ventricosa* F. Krauss, Amtlicher Bericht über die zwanzigste Versammlung der Gesellsch. deutsch. Naturforscher und Aerzte zu Mainz im Sept., 1842, p. 130.

1850. *Lyrodon ventricosus* F. Krauss (*partim*), Nov. Act. Acad. Cæs. Leop.-Carol. Nat. Cur., vol. xxii., pt. 2, p. 456, Tab. 49, figs. 2*c*–2*f*, (exclude figs. 2*a*, 2*b*).

1871. *Trigonia ventricosa* F. Stoliczka, Cretaceous Fauna of Southern India, vol. iii., The Pelecypoda; p. 315, pl. xv., figs. 9. 9*a*. (Palæontologia Indica.)

1875. *Trigonia ventricosa* J. Lycett, Mon. Brit. Foss. Trigoniæ, p. 119, and text-figures. (Palæontographical Society.)

1877. *Trigonia ventricosa* O. Feistmantel, Foss. Flora of the Gondwana System, vol. i., pt. 3, p. 164. (Palæontologia Indica.)

* J. de C. Sowerby (1), vol. vi., Tab. 594, figs. 3–5 (1828).

† J. de C. Sowerby (2), p. 346, pl. xxi., fig. 17.

‡ Koch and Dunker (1), p. 58, Tab. vii., fig. 2; Dunker and Meyer (1), p. 26, Taf. xi., figs. 4, 5.

§ Koch and Dunker (1), p. 59, Tab. vii., fig. 3.

‖ F. A. Roemer (1), p. 95, Taf. v., fig. 14; Dunker and Meyer (1), p. 27, Taf. xi., fig. 8.

1879. *Trigonia ventricosa* W. T. Blanford, in Medlicott and Blanford, Manual of the Geology of India, pt. 1, p. 261, with text-figure.

1880. *Trigonia ventricosa* O. Feistmantel, Foss. Flora of the Gondwana System, vol. ii., p. xxxvii. (Palæontologia Indica.)

1893. *Trigonia ventricosa* W. T. Blanford, in Medlicott and Blanford, Manual of the Geology of India (2nd edition revised and partly rewritten by R. D. Oldham), p. 225, with figure.

1900. *Trigonia ventricosa* G. Müller, Verstein. des Jura und der Kreide. Deutsch-Ost-Afrika, Band vii., p. 543, Taf. xix., figs. 4, 5.

1903. *Trigonia ventricosa* F. L. Kitchin, Jurassic Fauna of Cutch, vol. iii., pt. 2, The Lamellibranchiata; p. 104, pl. x., figs. 4–8. (Palæontologia Indica, Ser. IX.).

1905. *Trigonia ventricosa* A. W. Rogers, An Introduction to the Geology of Cape Colony, p. 291, fig. 25 (2).

Occurrence.—This widely distributed and very characteristic form occurs in the Marine Beds at various localities on the Sunday's and Zwartkop's Rivers. It was collected by Messrs. Rogers and Schwarz at a kloof on the left side of the Zwartkop's River, east-north-east of Red House (308), and was found to occur abundantly in a cliff at "Picnic Bush"; it is also cited from localities in the neighbourhood of Uitenhage, on the road to the top of Grass Ridge and in the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the Graaff-Reinet railway, about three miles from Uitenhage.* Mr. Rogers collected it on the left side of Coega Valley, half a mile down from the railway (463g), and in a small kloof three miles up the left bank of Sunday's River (14h, 15h). Stow remarked upon the great abundance of this shell in the cliff at "M'Loughlin's Bluff" or "Prince Alfred's Rest" on the Sunday's River. † Krauss found it in the left bank of Zwartkop's River below Uitenhage, associated with *Trigonia herzogi* and *T. conocardiiformis.*

In German East Africa, shells referred to this species have been found in strata ascribed by G. Müller to the Lower Neocomian and brought by him into relationship with the Uitenhage beds, at a locality a short distance to the north of the Nkundi stream, 29 km. north-west of Kiswere. There they occur with *Trigonia beyschlagi*, which shows strong resemblance to *T. crassa* Kitchin, from the Oomia marine beds in Cutch.

* Rogers and Schwarz (1), pp. 8–10. † Stow (1), p. 502.

In India, *T. ventricosa* occurs numerously at various localities in the marine beds of the Oomia Group in Cutch, notably in the neighbourhood of Oomia and Goonaree; it is also stated to have been found by King in an outlier of the Tripetty beds at Innaparazpolliam, to the north-west of Coconada on the south-eastern side of the Indian peninsula.* It is recorded, too, from the Margalla Pass in the district of Hazara, where it is said to occur in abundance.†

Remarks.—Trigonia ventricosa bears a general resemblance to members of the *aliformis* group of the section Scabræ, particularly to *T. aliformis* Park.,‡ with which it was confounded by von Buch, and to *T. scabricola* Lycett; § but the relative shortness and great height of the outline, the very strong anterior inflation, and the coarse and salient character of the ornaments on the anterior part of the adult shell, serve to separate it from all known members of the section in Europe. It has been repeatedly pointed out that much closer agreement is shown to *T. tuberculifera* Stoliczka, from a higher horizon in the Cretaceous rocks of Southern India. The resemblance appears to be remarkably great, but unfortunately Stoliczka's description and figures of *T. tuberculifera* leave something to be desired. I have elsewhere drawn attention to the fact that in the figure of the front view of Stoliczka's type ‖ the ribs of the right and left valve are represented as though placed opposite to one another at their frontal terminations; in *T. ventricosa*, on the other hand, as in other members of the section, these ribs alternate in position, and it seems probable that an error was committed in the execution of this figure of *T. tuberculifera*.

A comparison of *T. ventricosa* with *T. kraussi* sp. nov. will be found in the remarks appended to the description of the latter.

T. subventricosa Stanton, from the Belgrano beds of the Pueyrrydon Series in Patagonia,¶ so far as can be gathered from the description and figures of that shell, is of very similar type, but seems to be less strongly inflated, and to be of relatively more elongated form.

T. delafossei Bayle and Coquand,** from the Neocomian of Chili, also shows a general agreement with *T. ventricosa*, and may

* King (1), p. 229; Feistmantel (2), p. 164; Feistmantel (3), p. xxxvii.

† Wynne (2), p. 125; Medlicott and Blanford (1), p. 503.

‡ Parkinson (1), p. 176, pl. xii., fig. 9; Lycett (3), p. 116, pl. xxv., figs. 3–6 (1875).

§ Lycett (3), p. 130, pl. xxvii., figs. 4, 5.

‖ Stoliczka (2), pl. xv., fig. 10 (1871).

¶ Stanton (3), p. 18, pl. iv., figs. 19, 20

** Bayle and Coquand (1), p. 37, pl. viii., fig. 27; R. A. Philippi (1), p. 85, pl. xxxvi., fig. 4; Paulcke (1), p. 296, Taf. xvii., fig. 9.

perhaps be closely related. It appears, however, to have more closely spaced and less coarsely nodose ribs. To judge from the description and figures of *T. delafossei* given by Paulcke, the escutcheon is more sharply demarcated from the area than in *T. ventricosa; T. delafossei* also does not appear to have attained such large dimensions. Another South American form, *T. nepos* Paulcke, from the Neocomian of Chili, shows to some extent a similarity to *T. ventricosa*, especially if the smaller individuals figured by Paulcke * be compared with specimens of similar size; *T. nepos*, however, has more delicate sculpture and is also well distinguished by the peculiar arrangement of the ribs towards the frontal face. In the work cited above, Paulcke brings *T. nepos* and *T. delafossei* into close relationship; yet he perceives in *T. nepos* an exceedingly close resemblance to *T. baylei* Dollfus, † from the Kimeridge of Europe, and recognises in the similarity an indication of the scaphoid ancestry of these Cretaceous forms. It may be pointed out that the principal character upon which he relies, the existence of a more or less independent series of anterior ribs, is a feature to which, alone, such significance can certainly not be attached. It represents a plan of sculpture which has appeared repeatedly and independently in various *Trigonia*-stocks, and in *T. baylei* and other typical Jurassic Scaphoideæ is associated with well-marked characteristics which indicate the very high improbability of such direct relationship as that suggested. In *T. ventricosa, T. delafossei*, and *T. nepos*, just as in the *T. aliformis* group of Europe, the very prominent and highly inflated umbonal region, the extreme incurvation of the umbones, the relatively very narrow area and the crenulation of the shell margin, are characters which are conspicuously developed in these well-marked and specialised groups. In *T. baylei* and similar Scaphoideæ, the laterally compressed form, the weak umbonal incurvation, the nodose carinæ and delicately sculptured area, no less than the relations of frontal to lateral costæ, are also characters of specialisation, and judging by the evidence of early growth-stages, these shells had ancestry in simple clavellate forms. A similar though independent ancestry seems also very probable in the case of the various groups classed under the broad heading Scabræ.

In the published description of the *Trigoniæ* from the Oomia Group in Cutch, it is stated that the Indian specimens ascribed to *T. ventricosa* "although exhibiting great variability, offer no features

* Paulcke (1), p. 293, Taf. xvii., fig. 8.

† Dollfus (1), pl. xv.; Bigot (1), p. 309 [51], pl. xii., fig. 10.

except their state of preservation by which they may be distinguished from those occurring in South Africa."* Having due regard to the range of individual variation shown by the specimens which occur in the Oomia beds, I believed this statement to be quite accurate, but a reconsideration of this matter and a renewed comparison between a larger number of specimens now necessitates a slight modification. While it is seen that the limits of individual variation among the Indian specimens cover differences greater than those to be observed between the average characters shown by examples of the species from the one region and those from the other, it should be noted that in India many of these shells exhibit a somewhat less degree of inflation than that seen in most of the South African examples. The specimens from Cutch sometimes have the tubercular ornaments rather more prominently developed, though in certain cases the effect of prominence seems to have been enhanced by the mode of preservation of the shells. There is also a tendency to have the tubercles less closely crowded together and less regularly moniliform than in the specimens from South Africa. It is difficult to say in how far these characters may have been the product of strictly local conditions. There certainly appears to have been a greater range of individual variation and greater instability than is shown by the specimens from the Uitenhage beds. At the same time, the agreement between a selected series of specimens from the one region and a suite of individuals from the other is remarkably close, and, all things considered, I do not think that the points of difference, above noted, suffice for the establishment of two separate species, or, indeed, even for the satisfactory recognition of two well-defined local races.

Trigonia kraussi sp. nov.

Plate III., figs. 2, 2*a*.

1850. *Lyrodon ventricosus* F. Krauss (*partim*), Nov. Act. Acad. Cæs. Leop.-Carol. Nat. Cur., vol. xxii., pt. 2, Tab. 49, figs. 2*a*, 2*b* (exclude figs. 2*c*–2*f*).

Description.—The shell is relatively short, anteriorly very high, with the upper and lower margins rapidly converging posteriorly towards the very short siphonal margin. The valves are anteriorly very strongly inflated, but posteriorly compressed. The umbones are prominent, strongly incurved and markedly recurved, and situated close to the anterior end. The greatest height is attained

* Kitchin (1), p. 107.

at the umbo, and may exceed the total length. The valve is almost vertically truncated anteriorly and in its anterior part attains such relatively great depth that a flattened frontal face of considerable extent becomes developed.

In the youthful stage the ribs of the flank are concentric in arrangement, extending from the carinal angle to the frontal border. As growth proceeds, subsequently formed ribs terminate anteriorly at the frontal border but posteriorly at an increasing distance from the carinal angle. The ribs at the same time attain a more steeply inclined direction, and the last-formed rib of the frontal series is very short and almost vertical. In the early adult stage narrow, closely spaced ribs extend between the carinal angle and the upper terminations of the swollen frontal ribs, or may be looked upon as the attenuated upward prolongations of these since the two sets are so far in continuity. Successively formed narrow ribs, constituting a posterior series, have their upward terminations slightly removed from the carinal angle, and in the posterior half of a fully grown specimen these crowded ribs of the posterior series entirely occupy the flank. The ribs of the anterior series are very prominent and coarsely tubercular, and may be elevated to a height of 7 or 8 mm. above the surface of the interspaces. These ribs are very widely spaced, the interspaces reaching 8 mm. in breadth in the adult stage; on the frontal face the ribs sweep round in a broad curve towards the anterior valve-margin. The development of the earlier-formed ribs is not continued in the later growth-stages, so that in a large specimen the frontal face is partly without sculpture in its upper part, towards the valve-border. The ribs of the posterior series are at first vertically directed, but the majority of them have a marked backward inclination when traced downwards. They are relatively weak, and are separated by interspaces less than 2 mm. in breadth. The whole surface of the flank is crossed by crowded lines of growth which are most plainly visible in the wide interspaces between ribs of the anterior series.

The carinal angle is represented by a blunt, rounded fold in the adult shell. The area is very narrow, and is without ornamentation in the adult stage, except a strongly impressed median longitudinal groove. The escutcheon is relatively broad and is deeply excavated in form.

Dimensions.—

Length (approximate)	75 mm.
Height measured from the umbonal region	82 ,,
Greatest depth of a single valve	45 ,,

Occurrence.—Messrs. Rogers and Schwarz record the occurrence of this shell ("the large variety of *T. ventricosa*") * in the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the line from Uitenhage to Graaff-Reinet, about three miles from Uitenhage. The specimen from the South African Museum, here figured, is probably from the Sunday's River. Krauss met with this form in the left bank of the Zwartkop's River below Uitenhage.

Remarks.—This characteristic *Trigonia*, which belongs to the section Scabræ, may be said to exhibit in very exaggerated manner some of the most striking features which render *T. ventricosa* (Krauss) so conspicuous amongst the members of this section. *T. ventricosa*, though so well distinguished by its form and ornamentation, is in some respects comparable with the European *T. scabricola* Lycett or *T. aliformis* Park., and was even considered identical with the latter by L. von Buch.† *T. kraussi* is so far removed from European members of the section that a detailed comparison with these is unnecessary, and it only remains to draw attention to the characters which differentiate it from *T. ventricosa* and the apparently closely allied *T. subventricosa* which occurs in the Belgrano beds of Patagonia.

T. kraussi is principally distinguished by its large size and the very prominent character and wide spacing of the anterior ribs. Another striking feature is the great anterior inflation and extensive flattened frontal face. In other respects the resemblance to *T. ventricosa* is so great that I was led to ask Mr. Rogers whether he was aware of the existence of specimens intermediate in character between the extremes ; his reply, however, was in the negative. So many specimens of *T. ventricosa* have been obtained by various collectors, and the Uitenhage *Trigoniæ* are so well represented in European museums that we might certainly expect to find intermediate forms, if such existed, in some of the collections. No specimens connecting the extreme forms appear to have been found, and amongst the *Trigonæ* of the Oomia beds in Cutch the representatives of *T. ventricosa*, met with in abundance, agree with the smaller typical form in South Africa.

T. kraussi has approximately double the dimensions of *T. ventricosa*, but is, perhaps, slightly shorter relatively to height. The number of anterior ribs formed in the youthful and early adult stages may perhaps be not widely different, but the spacing of the ribs rapidly widens in the larger form, and the interspaces may reach 8 mm. in

* Rogers and Schwarz (1), p. 10. † von Buch (1), p. 23.

width. In the adult *T. kraussi*, within a space of 33 mm. measured backwards along the flank from the lower end of the frontal margin, three ribs only are included. At a height, measured from the umbo, which represents the full adult height of *T. ventricosa*, the anterior ribs on the flank of *T. kraussi* are already much more robust and more widely spaced than in *T. ventricosa*. The anterior inflation is also much stronger. These very well-marked differences in characters developed at a comparable stage in the two forms lead me to separate definitely *T. kraussi* from *T. ventricosa*. It may well be the case that we are here dealing with two branches of a not far removed ancestral stock, both of which have evolved along similar lines, but one more rapidly than the other. The more advanced type may be recognised in *T. kraussi*, from the fact that it exhibits all the late adult characters of *T. ventricosa* while yet in the early adult stage itself; the late adult characters of *T. kraussi* are never reached in *T. ventricosa*. It is highly improbable, indeed, that this giant form merely represents extreme individual variation in *T. ventricosa*, and its separation from this seems to me to be justified.

There is a close general agreement with *T. subventricosa* Stanton,* especially in the large dimensions, but the Patagonian shell is relatively more elongated, has the valves less strongly inflated, and the flattened frontal face less extensively developed. In *T. kraussi* the umbonal region is more narrowed in form and considerably more prominent, taking Dr. Stanton's figure to represent a typical specimen of the Patagonian shell.

Both *T. ventricosa* and *T. kraussi* are figured by Krauss as representatives of the same form, and he makes no mention of the differences to which I have above alluded, though these are plainly shown in the figures which accompany his description of *T. ventricosa*. In deciding which of Krauss's specimens are to bear the name *T. ventricosa* it is well to note that his description more accurately applies to the small specimens, and it may further be observed that when he spoke of the species as "particularly numerously" represented he must have referred to the smaller form. This alone has been abundantly collected and it has also been frequently spoken of in the literature under the name *T. ventricosa*. Moreover, no less than six authors have figured the smaller shells under the name given by Krauss.

* Stanton (3), p. 18, pl. iv., figs. 19, 20

TRIGONIA ROGERSI sp. nov.

Plate III., figs. 3, 3*a*; IV., fig. 1; V., fig. 2.

Description.—The shell is of somewhat elongated form; it is anteriorly high and is posteriorly more slender in outline and considerably produced. The valves are moderately inflated in the anterior half of the shell, and are posteriorly more compressed. Anteriorly, the surface of the valve curves round towards the frontal margin so as to give the shell some appearance of anterior flattening or even truncation, most marked in specimens of large size. The umbones are situated at about one-quarter of the total length from the anterior extremity. They are prominent, well incurved, and slightly recurved. The cardinal margin slopes down gradually, forming a long, almost straight outline, and passes by a rather abrupt curve into the short, convex posterior border. In front of the umbo the valve margin falls steeply at once to form the lengthy frontal border, gently and regularly convex in outline, which passes by a regular and broad curve, without break, into the lower border. This in turn has a gently convex outline, and slopes up gradually towards the posterior margin. The greatest height falls at the umbo.

The costæ of the flank are concentric in arrangement until the close of the neanic stage, becoming then more and more downwardly inclined, when traced from their commencement at the carinal angle. In an adult specimen the ribs in the anterior third of the shell are not at all curved in form as they pass obliquely down the flank, but on the frontal face of the valve they curve rapidly so as to approach the frontal margin horizontally. The successive costæ are more and more steeply directed until at about the middle of the valve their direction is vertical. Posteriorly to this they have a very slight backward inclination. The ribs in the anterior, inflated part of the shell are prominent, strongly nodose or tubercular, and are separated by interspaces as broad as the ribs themselves; on the frontal face the interspaces are much wider. The ribs of the posterior half of the shell are narrower and less prominent in character, are only weakly nodose, and are more closely crowded together. In a large individual, about a dozen large, prominent ribs may be counted in the anterior part of the valve. In the early adult period, occasional short rows of delicate nodes of unequal extent may be intercalated on the surface between the main ribs where these approach the valve margin on the frontal face. On the surface of the valves clearly marked lines of growth are well seen as they cross the interspaces, but are either little conspicuous or absent on

the tubercles of the ribs. In the largest individuals, characters of senility are seen in the imperfect rib-formation near the lower margin, and the replacement of sculpture by simple ridges and lines of accretion at the frontal margin, where the ribs may then be seen to terminate at some little distance from the actual margin.

For a distance of about 15 mm. from the umbonal apex a very delicately nodose, narrow marginal carina is present. It then dwindles abruptly and disappears, while the carinal angle becomes less marked when traced posteriorly and is replaced ultimately by a gentle and rounded fold of the valve surface.

The area is very narrow anteriorly, and gradually broadens posteriorly. For a distance of about 15 mm. from the umbonal apex it is ornamented by delicate, slightly granular, transverse ridges separated by narrow grooves. The terminations of these ridges at the carinal angle do not correspond strictly with the upper terminations of the ribs on the flank, but the ridges on the area are rather more numerous than these. Each of the ridges terminates inwardly in a delicate, transversely elongated node, a row of which takes the place of an inner carina. At a distance greater than 15 mm. from the umbonal apex the area is without sculpture, though two or three further inner-carinal nodes may be present. The area is divided by a well-marked longitudinal groove into a narrower, superior, and broader inferior portion. The groove is continued right to the posterior margin. At the posterior end of a specimen measuring 84 mm. in length, the area is about 20 mm. in breadth. The escutcheon is of great size and length, and at the middle of the shell it is much wider than the area. In its anterior half it is of well-excavated, concave form. Its ornaments consist of numerous, fine, beaded ridges or lines of delicate nodes passing from the inner-carinal nodes rather obliquely backwards across to the cardinal margin. At 30 mm. from the umbonal apex these ornamenting lines cease to be formed, and several of them situated posteriorly in the series do not extend to the cardinal margin. Posteriorly, the inner carinal ridge of the valve becomes obsolete and the smooth escutcheon ill-defined. The ligament space is relatively long, measuring 18 mm. in length in a specimen having a length of 84 mm. In each valve it shows at the cardinal margin a straight lath-like ridge, becoming gradually thinner when traced back from the umbo, separated from the escutcheon by a straight, deep, narrow groove.

The central tooth of the left valve is of relatively great size and prominence, and its inferior indentation is deep. The inner surface

of the valve margin is smooth, in the anterior part of the shell at least. If there is any crenulation at all, it is confined to the posterior half of the valve, and must be of a weak description.

Dimensions.—	(1)		(2)		(3)
Length (estimated)	78	.	84	.	135 mm.
Greatest height	53	.	58	.	92 ,,
Greatest depth of a single valve	19	.	23	.	32 ,,

Occurrence.—Obtained by Mr. Rogers from a bare slope W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop, Sunday's River (20h); also from Coega Valley, east of the railway, one mile up the line from Coega station (472g).

Remarks.—This is an elongated representative of the section Scabræ, and, generally speaking, it exhibits the normal characters of the section. It is remarkable, however, for its very large size and for the manner in which it shares the character of posterior elongation with other *Trigoniæ* from the Uitenhage beds and from the Oomia beds of Cutch. This prolongation at the siphonal end, and the absence of sculpture from the area in the later adult stages are characters similarly shown in members of the group of *Trigonia vau* and in *T. conocardiiformis* (Uitenhage Series) and in members of the group of *T. v-scripta* and certain degenerate Costatæ (in the Oomia beds). There are evidences of degeneracy in all these forms. In the specimen numbered (2) in the above table of measurements, one valve is almost complete at the siphonal border, and the form of the valve at that part suggests that in the complete shell a slight posterior gape may have been developed, just as in *T. stowi*.

In the neanic and early adult stages, *T. rogersi* bears a considerable resemblance to the same stages in *T. ventricosa* (Krauss). It differs, however, in details of the sculpture on the area and escutcheon, and with advancing growth, the characters of outline, degree of inflation, and ribbing of the shell are so widely distinct in the two forms as to need no comparison here.

Trigonia herzogi (Goldfuss).

Plate V., fig. 1.

1837. *Lyrodon herzogii* (Hausmann) A. Goldfuss, Petrefacta Germaniæ, Band ii., Lief. 6, p. 202, Tab. cxxxvii., fig. 5.

1850. *Lyrodon herzogii* F. Krauss, Nov. Act. Acad. Cæs. Leop.-Carol. Nat. Cur., vol. xxii., pt. 2, p. 453, Tab. 48, fig. 3.

1882. *Trigonia herzogi* G. Steinmann, Neues Jahrbuch für Mineralogie, Band i., p. 220, Taf. vii., figs. 1, 2; Taf. ix., figs. 1, 2.

Occurrence.—This is an abundant and characteristic form in the Sunday's River Beds. It was recorded by Hausmann from the neighbourhood of Enon, and by Krauss from the left bank of the Zwartkop's River below Uitenhage; also by Stow* from various localities on the Sunday's and Zwartkop's Rivers. A fine specimen sent to me from the South African Museum is from the Sunday's River (289). Messrs. Rogers and Schwarz found *T. herzogi* on the north side of the Zwartkop's River at a locality to the west of Rawson Bridge, and at Picnic Bush; also further up the river on the road from Perseverance Farm to the Salt Pan, and at Cuyler Manor. Near Uitenhage, they record this form from two beds of sandstone exposed in dry watercourses on the ascent of the Grass Ridge road; in the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the Graaff-Reinet railway; and on the road to Hillwacht, where the path leaves the plain. On the Sunday's River it was found near the top of the white krantz on Wolve Kraal, on the north bank of the river.

The collection made in 1905 by Mr. Rogers includes several specimens of *T. herzogi*, which came from the following localities: the left side of Coega Valley, two miles down from the railway (468g); from the valley east of the railway, one mile up the line from Coega station (474g); the cliff on Buck Kraal, Sunday's River (116h, 120h, 122h); and the cliffs on Zoet Geneugd, Sunday's River (99h).

Remarks.—*Trigonia herzogi* is well known from the striking figure given by Goldfuss, illustrating a fine specimen which was included in a small collection of Uitenhage molluscs obtained by Hertzog. These had been previously noticed briefly by Hausmann in his paper on the geology of South Africa.† The shell is conspicuous for its large size and elongated outline, its straight and lengthened cardinal margin and its straight, nodose ribs, backwardly inclined in the posterior half of a fully grown valve. It was referred by Pictet and by Lycett to the section Quadratæ. An excellent figure of the shell was given also by Steinmann, who included *T. herzogi* with *T. transitoria* Steinm. in the group Pseudo-quadratæ, the characters of which are briefly discussed below in the remarks appended to the description of *Trigonia holubi.* Steinmann has set forth in great detail the differences that distinguish *T. herzogi* from

* Stow (1), pp. 498–505.

† Hausmann (1), p. 1458.

T. transitoria, which occurs in Neocomian strata in Bolivia, Chili, and the Argentine Republic. *T. transitoria* shows a closer approximation of characters to the Clavellatæ; it is not so elongated in outline, and its strongly nodose ribs have a curved form and a forward sweep when traced downwards, throughout almost the whole extent of the flank. In *T. transitoria* the rows of nodes representing the marginal and median carinæ become joined by transverse rounded ridges at an earlier growth-stage than in *T. herzogi*, in which these rows of nodes, and that representing the inner carina, remain isolated and distinctly developed until traced farther back towards the siphonal margin of a fully grown individual. The escutcheon is smooth in its anterior part in *T. transitoria*, while ornamented at an early stage in the African shell; in *T. transitoria* the escutcheon, generally speaking, is more sparsely sculptured.

I have elsewhere pointed out the features of distinction between *T. herzogi* and *T. mamillata*, from the Oomia beds of Cutch.* *T. mamillata* shares the principal characters of the Pseudo-quadratæ, but is a shorter shell than *T. herzogi*, and is vertically truncated in front. In *T. mamillata* those ribs situated at the centre of the flank, and posteriorly to this, are slightly curved, and are directed anteriorly at their lower ends, while the corresponding ribs of *T. herzogi* are backwardly directed and are not curved. On the area of *T. mamillata*, the rows of more or less isolated nodes become united to form smooth transverse ribs nearer to the umbo than in the African form, in which, also, the lines of nodes and transverse ridges of the area are rather more closely spaced. In *T. mamillata* the tubercles are more closely crowded together in the ribs of the flank and are, generally speaking, more robust and conspicuous than in *T. herzogi*, particularly in relation to the size of the valve. The blunt transverse ridges of the area towards the posterior end of an adult specimen are broader and more strongly developed than in *T. herzogi*.

A comparison with *Trigonia holubi* is given in the remarks which follow the description of that form.

Two specimens depicted in the left-hand side of a text-figure published by Drs. Hatch and Corstorphine † represent *T. herzogi*, but very greatly reduced in size.

Trigonia holubi sp. nov.

Plate IV., figs. 2, 2*a*.

Description.—The shell is large and massive, almost oblong in outline, and usually vertically truncated in front, or with very steep

* Kitchin (1), p. 102. † Hatch and Corstorphine (1), p. 245, fig. 66.

forward obliquity ; the length is greater than the height. The nearly terminal umbones are little conspicuous and weakly incurved. The cardinal margin forms an almost straight line and slopes back very gently from the umbo. It forms posteriorly a sub-angular junction with the relatively long, slightly convex siphonal margin. The frontal margin is very slightly convex, more seldom quite straight, in outline, and passes below by a sharp curve or sub-angular junction into the lower border; this is more convex in profile. The inflation of the valves is relatively weak; the greatest height occurs at about the middle of the valve. A flattened frontal face is well developed in fully grown specimens. There is no definite carinal angle, but the area is well demarcated by the limits of its particular sculpture, which is contrasted with that of the flank.

The sculpture of the flank in the young shell consists of relatively strong concentric nodular ribs, four of which are already developed when the shell has attained a height of 10 mm. Subsequently formed ribs increase rapidly in prominence and robustness and become steeply inclined, so that after about ten ribs are developed all reach the inferior margin. The ribs of the adult shell consist of rows of large and prominent tubercles, some of which reach a diameter of 5 mm. Most of the ribs have a forward sweep when traced downwards ; an approximately vertical direction is attained only by those ribs situated in the posterior half of a fully grown valve, and these also are slightly curved in form, with the convex side directed posteriorly. The interspaces are rather narrower than the tubercles of the ribs. In the early and middle adult stages, the tubercles composing the ribs are well separated from one another on a given rib. In the late adult and senile stages the tubercles become closely crowded together and are contiguous. Towards the lower border of a fully grown individual the tubercles tend to become elongated in a direction parallel to the shell margin, and they may appear to coalesce with prominent ridges of growth. With senility the ribs become imperfectly developed, while crowded ridges and furrows of growth are more marked near the pallial margin. In the lower half of the anterior portion of the flank in an adult specimen some tubercles are somewhat unevenly dispersed, giving rise to an appearance of irregularity, with departure from the strictly linear arrangement. In a fully grown specimen about sixteen ribs are developed on the flank.

The area in the neanic stage is crossed by transverse ribs continuous with those of the flank. In the early and middle adult stages no ribs are developed upon it ; but a line of tubercles limits

the area above, a second row of less well-defined tubercles is situated just below the longitudinal groove, while a third row of well-spaced stronger tubercles limits the area below. Prominent transverse ridges or irregular ribs cross the area in the posterior half of an adult individual, terminating above and below in the marginal tubercles and also between them. These ridges make their first appearance somewhat abruptly, and become more strongly marked and also more irregular in their form and spacing towards the posterior end of the area, in a well-grown individual. A few may even pass over to the flank and be there partly identified with ridges of growth. The longitudinal groove of the area, which divides it into a narrower, superior, and broader inferior portion, forms a constriction in each transverse ridge.

The escutcheon is narrow and relatively very elongated. It is ornamented by irregular rows of coarse tubercles or prominent ridges which pass very obliquely across its surface and terminate anteriorly at the cardinal margin. They are seen to be frequently continuous with the ornaments of the area. The ligament pit is of narrow and elongated lanceolate form, and in a large individual extends to half the length of the escutcheon.

The central tooth of the left valve is very massive and prominent, with relatively narrow apical angle. The anterior tooth of the right valve is supported by a well-raised platform. At the posterior end of the valves the raised ridge on the internal surface which separates the siphonal channels is situated high up in the siphonal border and is of relatively great strength and extent; in a fully grown individual it can be traced for at least 25 mm. from the margin.

Dimensions.—	(1)	(2)	(3)	(4)
Length (about)	98	110	120	132 mm.
Greatest height	75	78	87	88 ,,
Depth of a single valve	18	20	22	25 ,,

Occurrence.—Specimens in the collection of the South African Museum came from the Sunday's River (285 to 288, 290 to 296, 299). Mr. Rogers collected this form on the left side of Coega Valley, half a mile down from the railway (458g). An immature specimen from Brentford, Knysna Estuary (150h), is also probably referable to *T. holubi*.

Remarks.—The characters of this shell appear to be on the whole very well defined, while the valves are especially conspicuous both by their large dimensions and their salient ornamentation. Most of the specimens submitted to me, in all of which the shell is replaced by coarsely crystalline calcite, have had the surface considerably

corroded by weathering. In these specimens the etching has attacked the shell along lines of weakness, and has brought the tubercles and ornamenting ridges into undue relief, which results in an appearance so deceptive that for some time I was in doubt whether these etched specimens should not be regarded as a distinct form. A careful comparison between these individuals and others which have not suffered from weathering shows that they agree in all essential characters and that a separation cannot on present evidence be established. In addition to differences due to preservation, there is some variation in the sculpture of the area and escutcheon which may be noted here. The transverse ornaments of the area are in some individuals more robustly developed than in others; on the escutcheon the linear coalescence of tubercles to form parallel, obliquely running ridges is more complete and regular in some specimens than in others, and the ridges replace the isolated tubercles at an earlier stage of growth. There is also some variation in the arrangement of the tubercles in the lower half of the flank of adult specimens near the frontal margin. The lower terminations of the ribs here tend to turn forwards along the more prominent ridges of growth; some of the tubercles may appear to blend with these ridges, which turn up sharply at the frontal face. Another point in which some variation is shown is in the form of the anterior profile of the shell. In some specimens there is vertical truncation in front, in others the outline of the anterior margin slopes forward somewhat, when traced down from the umbones, so that the foremost point of the shell is situated near to the junction of the inferior and anterior margins.

This is the form referred to by Sharpe as a *Trigonia* allied to *T. herzogi;* he gave the following description of specimens which were presented by J. S. Bowerbank to the Geological Society of London: "*Trigonia* sp. (?). This variety (or possibly distinct species) is closely allied to *Trigonia herzogi*, but is more quadrate in outline than the common variety, the anterior edge being truncate; and the costal rows of knobs turn forward as they approach the ventral border, instead of passing downwards and backwards. These specimens came from Algoa Bay, and apparently have been derived from the Sunday River district, from the aspect of their matrix." *

T. holubi clearly cannot be united with either the Clavellatæ or the Quadratæ, but its characters are those of the somewhat intermediate kind which led Steinmann to establish the group Pseudo-

* Sharpe (1), p. 202.

quadratæ, to receive *Trigonia herzogi* (Goldf.), the well-known Uitenhage form, and *T. transitoria* Steinmann, from Lower Cretaceous strata in Chili, Bolivia, and the Argentine Republic.* *T. neuquensis* Burckhardt,† which is found associated with *T. transitoria* in the Neocomian *Trigonia*-beds of Las Lajas (Rio Agrio, Argentine Republic), also falls within this division, and another example of the same group is *T. mamillata*, which occurs in the Oomia *Trigonia*-beds near Goonaree in Cutch.‡ These five members of the Pseudo-quadratæ show similar deviation from the characters of the two sections with which they may best be compared. Like the Quadratæ, they have the escutcheon well ornamented, and the sculpture of the area is in some respects very similar, especially in the manner in which transverse ridges, particularly in the late adult stage, may pass over to the escutcheon on the one hand and the flank on the other. These characters contribute largely to distinguish the group from the Clavellatæ, with which, both as regards the youthful ornamentation and the adult form, it has much in common. In the Quadratæ the area is usually divided by its longitudinal groove into a broader, superior, and narrower inferior portion; in the Pseudo-quadratæ the upper division is the narrower. A row of impressions or pits on the inner valve surface, near the pallial margin towards the posterior end, is present in the Quadratæ but absent in the Pseudo-quadratæ. In accordance with the position of the longitudinal groove of the area, the lower siphonal channel on the inner valve surface is relatively broad in the Pseudo-quadratæ, and may be almost twice as broad as the upper one.

T. holubi is most closely comparable with the Indian *T. mamillata*, to which it shows a striking similarity. In *T. holubi*, however, the valve has a rather less convex form, the longitudinal groove of the area is more strongly marked, and the tubercles of the ribs in the early and middle adult stages are much less closely spaced. The most important point of distinction lies in the development of the sculpture of the area. In *T. mamillata* the phase in which irregular transverse costæ crossing the area form a dominant feature is reached at a much earlier stage of growth than in *T. holubi*. Thus, in *T. mamillata*, strongly developed costæ appear on the area soon after the neanic stage is passed and long before half the adult dimensions are attained. In *T. holubi*, save for the longitudinal groove and its accompanying line of tubercles, the surface of the area is smooth, and only marked by lines of growth, until at least

* Steinmann (2). † Burckhardt (2), p. 74, Taf. xiv., figs. 4–6.

‡ Kitchin (1), p. 100, pl. ix., figs. 8, 9; pl. x., figs. 1–3.

half the adult dimensions are attained. The transverse ribs which are subsequently developed on the area are not so well defined or so robust as in *T. mamillata.*

From *Trigonia herzogi* (Goldf.),* *T. holubi* is readily distinguished by the considerably shorter form, the vertical anterior truncation, the more crowded and much more prominent character of the flank ornaments, and the later appearance of transverse sculpture on the area. In the middle of the flank of an adult specimen, the ribs of *T. herzogi* are straight, while those of *T. holubi* are curved. The backward slope of the posterior flank ribs in *T. herzogi* is another point of distinction.

There is a marked general similarity to *Trigonia transitoria* Steinmann,† from South America, but the ornamentation differs considerably. In *T. transitoria* the tubercles of the costæ on the flank are placed closely against one another through all adult stages instead of being openly spaced as in the ribs of *T. holubi.* In *T. transitoria* also, the development of transverse ridges on the area comes in at a much earlier stage of growth, and, in fact, this ornamentation is a marked character during a large part of the adult life. There appear to be other points of difference which it is unnecessary to enumerate.

T. neuquensis Burckhardt is at once readily distinguished from *T. holubi* by its much shorter and higher outline. Here, also, the transverse ridges of the area become a marked feature at an earlier growth-stage than in *T. holubi.* In *T. neuquensis*, the manner in which these ridges in the posterior part of the shell extend downward on to the flank is much more marked than in the most advanced stage in *T. holubi.*

Note on the Development of the Pseudo-quadrate Trigoniæ.

A strong contrast between the features of the neanic and adult stages may be observed very frequently in species belonging to various sections of this widely conceived genus, but it is seldom that a transition in characters so marked and abrupt as that shown in *T. holubi* is seen to occur during the adult period. The sudden acquirement of strong transverse ridges on the area, a character which is accompanied by a change in the manner of development

* Goldfuss (1), Band ii., p. 202, Tab. 137, fig. 5 (1837).

† Steinmann (1), p. 260, Taf. iii., fig. 3; Steinmann (2), p. 221, Taf. vii., figs. 3, 4, Taf. viii., figs. 1–3; Burckhardt (1), p. 21, pl. xxv., figs. 1–3; Burckhardt (2), p. 73, Taf. xiv., figs. 1, 2.

of the tubercles of the flank costæ—they become crowded closely together on a given rib—is a very striking feature. In *T. mamillata* from Cutch, these characters are also coincident, but they are acquired at a much earlier period of growth. The members of the Pseudo-quadratæ, in the three continents where they are known to occur, seem to have been destined to pass through a similar sequence of developmental phases, but these phases were not reached by all the species at the same time. Thus, *T. mamillata* is in advance of *T. holubi*. In *T. holubi*, the stage where the area is demarcated by an upper and lower marginal row of tubercles and marked by a median longitudinal row, persists until half the adult dimensions have been reached. In *T. mamillata*, this trituberculate stage is passed over rapidly and is superseded in very early adult life. In *T. herzogi* it is superseded by the transversely costate stage (the area alone is still referred to) at a somewhat later period of development, but still not so late as in *T. holubi*. A point of great interest is that in *T. mamillata* and *T. herzogi*, and also in *T. transitoria*, the trituberculate stage may be seen to pass into the transversely costate stage by the progressive transverse elongation of the tubercles in the three sets, and the gradual coalescence of the transverse ridges thus formed. In *T. holubi*, this intermediate phase of development is not so noticeable: it is very much suppressed or is wholly omitted.

The facts here briefly set forth seem to suggest that the group Pseudo-quadratæ may be of an artificial character to some extent—that the forms here included for convenience of classification are not strictly homogenetic; and many known parallel instances amongst molluscs and brachiopods give great probability to the truth of this idea. We must suppose all these forms to have been descended from true Clavellatæ, just as in the case of the Quadratæ of Europe, and it is a very striking circumstance that the characters which mark the Pseudo-quadratæ should appear approximately at the same geological moment of time in three widely remote continents. Yet these forms are unknown in the European area. The Post-jurassic development shown by the Quadratæ and Pseudo-quadratæ, each group representing offshoots from one or more clavellate stocks, took place along parallel though independent lines in the European area and in the southern development with which we are dealing. Within each area, again, the development in the supposed several genetic series (which were departing along the same general lines from the ancestral clavellate characters) may be supposed to have been in some degree independent.

Confining our attention to the Pseudo-quadratæ, it is difficult to believe that the salient characters by which all the members are distinguished could have been called forth by the ordinary process of natural selection alone. The acquirement of costation on the area coincident in direction with lines of accretion; the encroachment of this simple ornament from the area to the transcrescently sculptured flank in the late adult and senile stages; the prodigal expenditure of shell substance in producing massive sculpture of an increasingly irregular type in these same growth-stages; and the evident variation in many characters which indicates a certain instability of type; all these point to racial degeneracy. A comparison of the Pseudo-quadratæ from India, South Africa, and South America, shows that in all of them this degeneracy was expressed as the culmination of a definite sequence of developmental phases. The facts do not warrant the supposition that the members of the group were wholly independent of one another. Their similarity in leading characters was perhaps due, in varying degree, to a number of causes: a certain community of ancestry; continued intercourse until checked by divergence; and at the same time the constant influence of natural selection; all these may have played a part. But it seems difficult to escape from the belief that innate racial tendencies of a very definite kind found their expression in representatives of these *Trigonia*-stocks at the same geological period. Had the members of these genetic series been more passive, so to speak; had they been more plastic and more completely amenable to the call of natural selection, it is scarcely conceivable that environmental conditions should not have occurred at some earlier time which would be capable of producing closely similar results. But the advent of the Quadratæ in Europe, and of the comparable though independent Pseudo-quadratæ of the south, took place, so far as we know, invariably in Neocomian times.

Trigonia vau Sharpe.

Plate VI., figs. 1, 1*a*, 2, 2*a*, 2*b*, 3.

1856. *Trigonia vau* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 194, pl. xxii., fig. 5.

? 1867. *Trigonia vau* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., pl. vii., fig. 8.

Occurrence.—The record of occurrence given by Sharpe was "Sunday River, in greenish-grey grit, with fragments of wood and shells; and in a shelly grit at the Zwartkop River." Speci-

mens preserved in the collection of the Geological Society of London are labelled "Sunday River" (Atherstone and Bain), "Prince Alfred's Rest" (Rubidge), and "Zwartkop River" (Rubidge). Specimens sent to me from the South African Museum are from the Sunday's River. Messrs. Rogers and Schwarz record *T. vau* from the following localities: in the neighbourhood of Uitenhage, ascending the Grass Ridge road, in the uppermost of three beds of sandstone exposed in the dry water-courses, and in the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the Graaff-Reinet line; on Sunday's River, in the upper beds exposed in a white krantz on Wolve Kraal, on the north bank of the river. In 1905 Mr. Rogers collected specimens 300 yards below Addo Drift (Tunbridge's), left bank of Sunday's River (40h, 41h, 42h). An immature specimen (46h) from the same locality, may also belong to *Trigonia vau.*

Remarks.—A large specimen of *T. vau* sent to me from the South African Museum attains a height of 50 mm., measured from the umbo. The ribbing of the flank ceases to be developed at a distance of nearly 10 mm. from the inferior margin, in the neighbourhood of which the shell surface is marked only by ridges and furrows of growth.

Sharpe gave a very accurate and characteristic figure of this remarkable form, but the differences which distinguish *T. vau* from *T. stowi* appear up to the present to have escaped observation, and it is probable that the shells cited under the name *T. vau* by Stow* are in reality to be ascribed to *T. stowi* sp. nov. I have had the opportunity of examining and comparing a considerable number of excellently preserved specimens of these two *Trigoniæ*, and find that the characters which distinguish them from one another are very constant. Several fully-grown shells of *T. vau* sent to me from South Africa agree very perfectly with the original type and other individuals in the collection of the Geological Society. The points of distinction which may be readily observed in the adult shells of *T. vau* and *T. stowi* are set forth in the remarks which follow the description of the latter. During the youthful growth-stage, however, these two forms cannot be separated, so that it is uncertain to which must be ascribed a young specimen obtained by Messrs. Rogers and Schwarz at Walton's Farm, just below Dunbrodie on the Sunday's River (307), and another individual measuring 17 mm. in length, collected between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the Graaff-Reinet railway (309). There is the same doubt concerning an immature

* Stow (1), pp. 199-505.

specimen from Addo Drift (46h). For the same reason it is uncertain whether the young individual figured by Tate really represents the true *T. vau*. Tate's figure, which represents the specimen in twice the natural size, unfortunately does not give a very satisfactory picture of the youthful characters of either of these shells.

The close agreement in the characters of the neanic stage reveals the near relationship of these two forms, and, indeed, such a relationship might reasonably be inferred from a comparison of adult characters, which coincide in a remarkable manner as regards the ribbing of the flank and the posterior elongation. Other shells, however, which when adult exhibit similar peculiarities of form and ornamentation, differ widely from *T. vau* and its associate when in the youthful stage. These are the members of the *Trigonia v-scripta* group in the marine Oomia beds of Cutch,* and a comparison of their youthful characters and those of *T. vau* and *T. stowi* is given in the remarks which are appended to the description of the latter. *T. stowi* when adult approaches closely in many particulars to *T. v-scripta* itself, but the adult *T. vau* agrees much more closely with *T. dubia* Kitchin, so far as the unsatisfactorily preserved Indian specimens allow of comparison. In consequence of imperfect preservation, the nature of the sculpture in the youthful stage of *T. dubia* is not known, but it appears reasonable to assume that it bears closer relationship to the other members of the group of *T. v-scripta* than to *T. vau*. In the adult stages, too, points of distinction between *T. dubia* and *T. vau* are not wanting. These have been set forth in my account of the characters of *T. dubia* † as follows: "In *T. vau*, the ribs of the anterior series, though narrow and crowded as in *T. dubia*, are seen to be upwardly inclined as they depart from their point of meeting with the posterior series, and are crossed obliquely by the lines of growth. In *T. dubia*, on the other hand, these anterior costæ are placed in a direction quite, or almost, parallel to the inferior border, and the angle of the lateral V is therefore not so acute. Moreover, before individuals of *T. vau* have reached half their full dimensions, the costæ of the frontal series cease to be formed close to the frontal border. There arises, therefore, a space devoid of ornamenting ribs, marked only by ridges and furrows of growth, and bounded posteriorly by the last-formed obliquely directed costæ of the frontal series. This peculiar character is totally absent in *T. dubia*, in no specimen of which is a frontal unsculptured space seen, although in respect to size

* Kitchin (1), p. 65. † Ibid., p. 69.

all the individuals examined considerably exceed the dimensions at which this feature becomes noticeable in *T. vau*. . . . Sharpe's type is of larger dimensions than the known specimens of *T. dubia*."

The extent to which an unsculptured space near the lower part of the frontal margin may be present in *T. vau* is really somewhat variable, but a few of the lowest ribs of the anterior series seem always to fail to extend at their upper terminations to the valve margin. In some individuals, two or three of these lower ribs may be slightly bent down at their anterior ends in manner reminiscent of the strong, angular bending at the front end of these ribs in *T. stowi*, as well as in the Indian *T. v-scripta*. It may also be noted that although the inclination of the frontal series of costæ in *T. vau* is always as steep as in the specimen depicted in Sharpe's figure, yet these ribs may in some instances attain a stronger development and may be of a rather more robust character.

A shell possibly related to *T. vau* is *T. kühni* G. Müller,* from Neocomian strata at a locality 23 km. west-south-west of Mtshinga in German East Africa. To judge from the description and figures, this is distinguished by an angular rib arrangement very similar to that exhibited by the members of the group of *T. v-scripta* in India, and *T. vau* and *T. stowi* in South Africa. *T. kühni* seems to differ, however, by its less equilateral form and the persistent ornamentation of its area. The figure of an imperfect specimen of *T. kühni* (fig. 8) shows a curved frontal profile and the ribs of the frontal series obliquely crossing the growth-lines in manner that recalls the same characters in *T. vau*, though still more reminiscent of *T. recurva* Kitchin, from the Oomia beds. It is as yet not possible to say, however, whether *T. kühni* is more nearly related to *T. vau* or to the group of *T. v-scripta*, though it may be anticipated that a study of the youthful characters will ultimately throw light on this point.

Trigonia heterosculpta Stanton,† from the Belgrano beds (Lower Cretaceous) of Patagonia, is very probably closely related to *T. vau*, but differs by the much shorter and more elevated triangular figure. The first-formed ribs of the posterior series are vertical or backwardly inclined, and not forwardly sloped as in *T. vau*, while several successive anterior ribs terminate abruptly on the flank of a single vertical posterior rib. In the neanic stage, however, the plan of sculpture as well as the form of the valve appears to agree closely with that of *T. vau*.

* G. Müller (1), p. 561, Taf. xxv., figs. 6–8.

† Stanton (3), p. 20, pl. iv., figs. 16–18.

R. A. Philippi* has figured some Chilian forms (for example, *T. arsinoe* Philippi, *T. foveata* Philippi) which may be related to *T. vau;* they are characterised by great posterior elongation, very convex anterior profile, and two series of ribs on the flank meeting at an angle. The general aspect, indeed, at once suggests the probability of relationship with the two South African types, but the Chilian shells are so unsatisfactorily figured, and their preservation appears to have been so imperfect that further and critical comparison is not possible.

Whiteaves has drawn attention to the features wherein *Trigonia diversicostata* Whiteaves,† from the Cretaceous of Queen Charlotte Islands, bears resemblance to *T. vau.* These are: the elongated and posteriorly strongly produced figure of the shell, the convex anterior profile and recurved umbonal region, and the general plan of sculpture on the flank. In *T. diversicostata,* however, the anterior ribs are much coarser in character than in *T. vau*, and are directed almost parallel to the lower valve margin, thus forming a right angle with the posterior ribs instead of an acute angle. A good distinctive feature is seen in the area of the Canadian shell, which is coarsely ornamented by strong longitudinal ribs, and this alone is sufficient to indicate that the two forms are in no way nearly related, but that the common characters of shape and broad plan of flank sculpture have been quite independently attained. Whiteaves ascribes *T. diversicostata* to the section Scaphoideæ, but all members of this division bear evidence of a clavellate ancestry, and longitudinal ornamenting ridges on the area are unknown amongst them. Such ornaments are essentially characteristic of the Costatæ, from which *T. diversicostata* was quite probably derived, and rapid divergence from the typical pattern of the section might well result in this aberrant form, in manner analogous to that exhibited in some of the modified Costatæ of the marine Oomia beds in Cutch. *T. vau* shows no signs of a connection with the section Costatæ at any early growth-stage that can be studied, but the ornaments of the area are transverse from the first.

The peculiarly ornamented *Trigonia doroschini* Eichwald,‡ from the Neocomian of Tukusitnu Bay (Alaska), may finally be brought into comparison. This appears to me, however, to be well separated from the group of *T. vau* (as well as from the group of *T. v-scripta* in India) by the more truncated and less convex anterior margin and by the manner in which the frontal ribs are directed at right angles

* R. A. Philippi (1), pls. 34, 35. † Whiteaves (1), p. 68, pl. x., fig. 1.
‡ Eichwald (2), p. 180, pl. xiii., figs 12–14; xiv., figs. 1–4.

to the frontal margin. It seems doubtful from Eichwald's figures whether a single form alone is represented, for it is difficult to believe that the originals of pl. xiii., fig. 12, pl. xiv., fig. 1, and pl. xiv., fig. 3 can belong to one species. Other points in which these differ from *T. vau* are the great extent of the frontal ribs, the horizontal position of these, and the persistent transverse ornaments on the area. Eichwald's description and figures leave the affinities of *T. doroschini* obscure, but I think it improbable that it is related to the group of *T. vau*.

Trigonia stowi sp. nov.

Plate VI., figs. 4, 4*a*, 4*b*, 5; VII., fig. 1.

Description.—The shell is of very elongated form, moderately inflated, anteriorly pointed, posteriorly very much produced, and slightly gaping at the siphonal margin. The umbones are situated at some point lying between one-quarter and one-third of the shell's total length from the anterior extremity; they are well incurved and slightly recurved. The umbonal region is fairly prominent and inflated. Posteriorly to the umbo, the very long cardinal margin forms a straight or very gently concave outline and passes posteriorly by a curve into the short, convex siphonal margin. Anteriorly to the umbo, the valve margin slopes downwards with straight profile to the projecting anterior extremity, where it forms a sub-angular or sharply curved junction with the lower margin; the latter forms a gentle and evenly convex profile as it is traced between the anterior and posterior extremities of the shell.

At no stage of growth is a marginal carina developed; in the youthful stage its place is represented by a blunt carinal fold which passes with advancing growth into a still broader and less well defined rounded fold of the valve. At the siphonal end of an adult individual this loses definition and the valve becomes evenly convex.

In the youthful shell, until the valve attains a height of about 8 mm. measured from the umbonal apex, the ornamentation consists of numerous, crowded linear ribs which are parallel to the lower margin and extend from the frontal border across the flank; they pass over the carinal angle and across the area. Up to a distance of between 5 mm. and 10 mm. from the umbonal apex these ribs extend across the escutcheon also, and terminate either at the cardinal margin or just before reaching it. Subsequently they cross the area though not the escutcheon, until a distance of about 10 or 12 mm. from the umbonal apex is reached, after which they occupy the flank only, terminating at the carinal angle, while the area subse-

quently remains smooth. In the space between 10 mm. and 20 mm. from the umbonal apex, the very blunt ridge demarcating the area from the escutcheon is ornamented by minute, transversely elongated nodes or short raised lines, each measuring about one millimetre in length. At a distance of about 10 mm. below the umbo the ribs on the flank become bent down in the middle in angular form and become more widely spaced. The transition from the straight to the angularly bent flank-ribs is somewhat sudden. Three or four bent ribs are successively produced, having a more delicate anterior and more robust posterior limb, and an increasing acuteness of the angle. Subsequently, an anterior and a posterior series of inclined ribs may be spoken of, not strictly coinciding with each other in number. The anterior ribs, numbering about 14–16 in the adult, often cease to extend to the frontal margin after the shell has attained half its adult dimensions; their upper, anterior terminations are situated on the flank at an increasing distance from the margin, and forming acute angles with these, with upwardly directed apices, are several short, steeply inclined, weak and rather broader ribs. Each of these is only a few millimetres in length and might be considered to represent the downwardly bent anterior termination of a rib of the anterior series. The most forward portion of the flank is usually devoid of sculpture and marked only by ridges and furrows of accretion. The lowest ribs of the anterior series become in varying degree irregularly nodose or broken into wavy lines of nodes with loss of regularity near the lower valve margin. The ribs of the posterior series have their upper termination at first close to the carinal fold, and successively at a gradually increasing distance from this, so that a narrow portion of the flank adjacent to the fold is smooth. These ribs are not developed to the posterior end of the flank in the adult, but there is here a smooth tract only marked by lines of growth. The ribs of the posterior series, developed to the number of about 14, are very steeply inclined, and all have a slight forward slope. They are of rounded form, are about 3 mm. in breadth, and have slightly narrower interspaces.

The area is relatively narrow, and is marked throughout the adult period by a longitudinal linear depression. In the posterior half of the area this marks off a narrow superior and broader inferior portion. There is no defined inner carina, and the line of delicate and imperfectly developed nodes which marks the inner limit of the area at a distance of 10–20 mm. from the umbonal apex is a transitory feature, and does not persist with subsequent growth. The escutcheon is relatively very long and is of lanceolate form, and

though imperfectly demarcated from the area, it is marked by its excavated form and smooth surface. Ridges of growth which cross the area are replaced by very delicate and scarcely perceptible lines of accretion on the escutcheon. At a distance of 15 mm. from the umbones the escutcheon in each valve is fully as broad as the area. The ligament pit is relatively short and broad.

Dimensions.—	(1)	(2)	(3)
Greatest length	80	95	110 mm.
Height, measured from the umbo	42	44	50 ,,
Greatest depth of a single valve	14	15	20 ,,

Occurrence.—Marine Beds of Sunday's and Zwartkop's Rivers. Specimens in the collection of the Geological Society of London are labelled "Zwartkop River" (Rubidge); "McLoughlin's, bed No. 5" (Stow); "Above Modder Drift, No. 3 bed" (Stow).* In the British Museum (Natural History) a fine specimen is labelled "Sundays River, Pont." A specimen sent to me from the South African Museum is believed to come from the Sunday's River cliffs. An immature specimen, 15 mm. in length, and a portion of the flank of an adult in the form of an external mould, resembling *T. stowi*, were collected by Messrs. Rogers and Schwarz at Walton's Farm on the Sunday's River, just below Dunbrodie (307). These may probably represent *T. stowi*, though they might equally well be ascribed to *T. vau* so far as their characters allow of determination. Another immature specimen, from the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the Uitenhage–Graaff-Reinet railway (309) may also perhaps belong to this form. Mr. Rogers collected *T. stowi* in a small kloof, three miles up the left bank of Sunday's River (17h). A hand-specimen containing one complete and two fragmentary valves was also obtained by him from a cliff W. 20 S. from Comley's house, right bank of Sunday's River (90h).

Remarks.—This form shows some variation in regard to the shape of the frontal profile and the position of the umbones in relation to the anterior extremity. In some examples, the anterior sculpture is more robust and more regular than in others. The thickened and downwardly directed terminations of the anterior ribs are sometimes a very prominent feature, in other cases they are less noticeable. In some individuals the anterior ribs are very closely spaced, and towards the lower part of the adult valve may be much broken up into nodes (as exemplified by specimen 17h). Sometimes a small portion of the flank, most anteriorly situated, is

* See Stow's table of cliff-exposures at localities on "Upper Sundays River" and "Lower Sundays River"; Stow (1), fig. 3.

smooth, in other cases the ribbing extends to the frontal margin at all parts. Near the pallial margin of large individuals senile characters may be seen in the cessation of sculpture and the appearance of several strong furrows of accretion.

Two right valves in the specimen numbered 90h have a more rounded and less sharply pointed anterior profile than any of the other specimens studied. They also have the umbones rather more anteriorly placed. The other extreme, illustrating the less inequilateral form of the valves and the more marked pointing of the anterior profile, is shown by an individual from the collection of the South African Museum. Characters quite intermediate between these extremes are exhibited, for example, by a specimen numbered 12006 in the collection of the Geological Society of London. I believe, therefore, that the material examined only suffices for the establishment of a single species.

Stow appears to have believed this form to represent *T. vau* Sharpe. When dealing with the *Trigoniæ* of the Oomia beds of Cutch, I made reference to *T. stowi* as an undescribed form allied to *T. vau*.* In addition to the specimens there referred to, I have since had the opportunity of examining further material in the collections of the Geological Society and the British Museum (Natural History), and also the fine specimens sent to me from South Africa. *T. stowi* is a very well characterised form, peculiar for its elongated outline, its pointed anterior extremity and greatly produced posterior region, its striking flank-sculpture and its siphonal gape. Although in many points, and particularly in the sculpture of the adult, it very strongly recalls the Oomia *T. v-scripta* Kitchin, yet its youthful characters plainly reveal its close relationship to *T. vau* Sharpe (see above). Until the young shell has attained a height of about 10 mm., these two African forms are so alike that I have been unable to find any feature by which they may with certainty be distinguished. In the adult stage, however, *T. stowi* has a more elongated outline and is more strongly produced posteriorly; its umbones are relatively further removed from the anterior extremity; the upper and lower valve-margins converge towards the front to join in more or less pointed form, and produce a frontal profile which stands in contrast to the sweeping convex outline of the frontal margin in *T. vau*. The angularly bent and swollen anterior portions of the ribs in the frontal series, which produce such a peculiar pattern in the sculpture of the anterior quarter of the flank in *T. stowi*, are developed to a much

* Kitchin (1), pp. 66, 74.

less noticeable extent in *T. vau*, and the bending is absent in some individuals.

When studied in connection with the shells of the group of *Trigonia v-scripta* from the Oomia beds of Cutch, *T. stowi* can only be closely compared with *T. v-scripta* itself. Though, when adult, it resembles this in most striking manner in the backward position of the umbones, the posterior elongation and general form, and especially in the character of the flank ornamentation, *T. stowi* may be readily distinguished by its relatively more elongated and posteriorly attenuated figure, and its anteriorly more acutely converging upper and lower margins. *T. v-scripta* is a shorter shell relatively to height, particularly in the late adult and fully grown state, while its valves are somewhat flatter and less inflated. In the youthful stage the two are widely different in character; *T. v-scripta* then has a very few coarse concentric flank-ribs, which, continuing across the well-marked carinal angle, pass obliquely forwards over the area in the form of attenuated thread-like raised lines, and terminate at a delicate linear ridge which represents an inner carina. Similar characters distinguish the young *T. recurva*, another Oomia form. This, like *T. stowi*, has strong posterior elongation in the adult, and a smooth tract on the posterior portion of the flank; but it is well contrasted by its much smaller size, its rounded convex frontal profile, its more crowded and much less steeply sloped anterior ribs, and its imperfectly developed, short posterior ribs.

T. heterosculpta Stanton,* from the Belgrano beds (Lower Cretaceous) of Patagonia, is very probably a related form. Its youthful characters are closely similar to those of *T. stowi*, but the adult shell is much shorter, more triangular in form, and much less elongated posteriorly, while there are marked differences in the details of sculpture.

Trigonia conocardiiformis (Krauss).

Plate VII., figs. 2, 2*a*, 2*b*, 3, 4.

1843. *Lyriodon conocardiiformis* F. Krauss, Amtlicher Bericht über die zwanzigste Versammlung der Gesellsch. deutsch. Naturforscher und Aerzte zu Mainz im Sept., 1842, p. 130.

1850. *Lyrodon conocardiiformis* F. Krauss, Nov. Act. Acad. Cæs. Leop.-Carol. Nat. Cur., vol. xxii., pt. 2, p. 454, Tab. 49, figs. 1*a*–1*d*.

* Stanton (3), p. 20, pl. iv., figs. 16–18.

1879. *Trigonia conocardiiformis* J. Lycett, Mon. Brit. Foss. Trigoniæ, pp. 210, 211, and woodcuts; p. 230. (Palæontographical Society.)

1903. *Trigonia conocardiiformis* C. Burckhardt, Beiträge zur Kenntniss der Jura- und Kreideformation der Cordillere. Palæontographica, Band l., Taf. xiii., figs. 3–5.

Supplementary Descriptive Note.—Krauss gave an admirable detailed description of this very characteristic shell, but I am able to supplement this by some additional observations, based on the examination of material more favourably preserved than that which appears to have been at his disposal. There are one or two points, also, in which the figures accompanying Krauss's description are rather misleading.

With regard to the ribbing of the flank, it must be noted that this does not always strictly conform with the simple plan illustrated in the figures given by Krauss and Lycett. It may be remarked that if the figures of the German author are imperfect, that given by Lycett to illustrate the exterior of a left valve is still less characteristic, although it was intended to supply the deficiencies of the earlier illustrations.

Several specimens now examined are in such condition as to show the form of the sculpture in early growth-stages, and two individuals, in particular, have the ornaments of the nepionic and neanic stages well preserved. One is an imperfect left valve which measures 9 mm. in length, and would be 7 mm. in height if uninjured at the pallial border; it occurred in a hand-specimen, containing adult *T. conocardiiformis*, *T. vau*, and other typical forms, from the Sunday's River. The other specimen is an immature individual having both valves in place, imperfect posteriorly, but beautifully preserved in the umbonal region. This was collected by Mr. Rogers from a cliff on the right bank of Sunday's River on Commando Kraal (104h). Other specimens, also, show the ribbing of the neanic stage, though less perfectly. It is seen that until the valve attained a height of about 6 mm., measured from the umbonal apex, the flank was ornamented by simple concentric ribs, running parallel to the lower margin. Close to the apex the crests of the ribs are situated at a distance of about 0·5 mm. apart; at about 5 mm. below the apex the distance between the ribs has increased to 1 mm. These concentric ribs extend to the frontal margin. Traced backwards, they pass over the flank to a definite carinal ridge, and becoming more delicate in character, turn sharply forwards and pass across the relatively narrow area. There is no inner carina

even at this early stage, but the ribs encroach slightly upon the smooth escutcheon. This is clearly seen in the neanic stage, where the escutcheon begins to increase rapidly in breadth. Very close to the umbonal apex, however, it is difficult to observe traces of an escutcheon, and here the attenuated and delicate linear ribs of the area pass obliquely forward until almost reaching the cardinal margin, when they die out. Where they disappear, very close to the cardinal border, the ribs are extremely attenuated and crowded, while directed to form an acute angle with the valve-border. The longitudinal linear groove of the area which becomes so marked a feature in the adult, is only faintly indicated at the close of the neanic stage.

As the succeeding growth-stage is entered upon—that is, when the valve exceeds 8 mm. in height—the carinal angle rapidly becomes rounded and blunt, and soon takes the form of a broad fold. The ribs of the flank are now prominent and robust, and are separated by interspaces 3 mm. broad. They pass obliquely downwards when traced forwards. There is some variation shown in the relation of the anterior ribs to the succeeding posterior ones in the adult stage. Sometimes the first four or five strong ribs have their posterior terminations on the flank at successively greater distances from the carinal fold. Immediately behind these, and forming a separate series having an almost vertical arrangement, are the numerous and much more delicate ribs of the posterior series. They have their superior terminations immediately below the carinal fold. The sixth or seventh rib of the anterior series is in continuity with the second or third rib of the posterior series, forming the lower and more strongly developed portion of it, this lower portion being directed to form a very obtuse angle with the upper portion. Posteriorly to this, the ribs are not divisible into two series. In other specimens, however, the successively formed ribs have their upper terminations alike close under the carinal fold of the valve, and there is no tendency to division of the ribs into two series. There is also considerable variation in the strength and number of the ribs. In some specimens the ribs are more strongly developed and are rather less numerous than in other individuals of equal size; sometimes their more strongly swollen character may be particularly noticeable on the posterior half of the flank.

The area throughout the adult stage is devoid of ornamentation except the well-marked longitudinal groove. The escutcheon is of very elongated lanceolate form. It is not separated from the area by any definite carinal ridge, but is well marked off for the most

part by being sunk in concave form. Towards the posterior end it is scarcely demarcated.

Dimensions.—*Trigonia conocardiiformis* may attain very large dimensions. A specimen presented by Atherstone to the Geological Society of London has a maximum length of 164 mm. This specimen, which is not quite complete at the lower margin under the umbonal region, must originally have had a height (measured at this part) of 95 mm. The ligament groove is 45 mm. long. A specimen figured by Krauss is 84 mm. in length and 42 mm. in height (at the umbonal region), while the depth of a single valve, measured from the figure, is 24 mm. In several individuals examined by me, the height is somewhat greater than this, in relation to the length.

Occurrence.—This form is found in the Marine Beds at various localities on the Sunday's and Zwartkop's Rivers. It was obtained by Messrs. Rogers and Schwarz from the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the line from Uitenhage to Graaff-Reinet (297, 298); also at the white krantz on Wolve Kraal on the north bank of Sunday's River. The same authors have mentioned the occurrence of this shell in a conglomeratic bed at Plettenberg's Bay.* Specimens in the collection of the South African Museum are from the Sunday's River. In 1905, Mr. Rogers obtained examples in the cliff on Commando Kraal, right bank of Sunday's River (104h); in the highest beds on Zoet Geneugd, right bank of Sunday's River (67h); on a bare slope W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop, Sunday's River (21h); and from the Nek S. 33 E. from Comley's house, right bank of Sunday's River (86h).

Remarks.—A very striking feature exhibited by this *Trigonia* is the sudden transition of sculptural characters at the close of the neanic stage. The abrupt manner in which the crowded concentric ribs give place to coarse, widely spaced, inclined ribs, recalls the analogous transition in *Trigonia vau* and *T. stowi;* in these, the youthful stage has similar though more delicate concentric ornaments, and these are replaced almost as abruptly by angularly bent, coarse ribs. The youthful characters of *T. conocardiiformis* seem perhaps to suggest an ancestry similar to that from which *T. vau* and its ally were derived. In the young *T. conocardiiformis*, however, the carinal ridge is more clearly defined, and in passing across this the ribs are sharply bent to form an angle. The early characters do not seem to indicate alliance with either the Scabræ

* Schwarz (1), pp. 53, 61; Rogers and Schwarz (1), p. 5; Rogers (1), p. 295.

or the Costatæ; but in view of the remarkable manner in which widely divergent types of *Trigonia* in the Oomia beds of Cutch show, by their neanic characters, their relationship to the Costatæ, it would not have been surprising to obtain evidence of a similar descent in *T. conocardiiformis.* The young stages, however, exhibit no trace of longitudinal ornamentation on the area, and it is difficult to surmise its true derivation.

T. conocardiiformis, by reason of its peculiar characters of outline and sculpture, has for long held a somewhat isolated position among the representatives of the genus. Lycett at first expressed the belief that it is an abnormal example of the Clavellatæ, only remotely related to other members of the section;* but he afterwards modified his opinion and associated this form with the "crenulated examples of the Scabræ." † Definite indications of such a relationship, as we have seen, are not to be recognised.

It is a point of great interest that on the South American continent, an apparently very close ally of *T. conocardiiformis* has been found to occur, and in association with two members of the Pseudo-quadratæ. The shells described by Burckhardt ‡ under the name "*Trigonia* aff. *conocardiiformis*" were collected from strata ascribed to the Lower Neocomian at Las Lajas (Argentine), and they certainly bear a very remarkable resemblance to this South African form. In general figure and outline the similarity is very striking, while differences in the hinge apparatus of the left valve are of a minor character. The principal points of distinction are in the nature of the sculpture of the flank in the adult stage; regarding the sculptural plan in the youthful stage of the South American shell, no information is as yet forthcoming. The tendency in some few individuals of *T. conocardiiformis* to show a development of two distinct series of ribs on the flank during the early adult stage is illustrated in more complete and emphasised manner during the whole adult period in the South American shell. Most of its anterior ribs, though in continuity with ribs of the posterior or vertical series, form an obtuse angle with these, and pass across the flank towards the frontal border in a direction more nearly horizontal than the downwardly directed anterior portions of the ribs in *T. conocardiiformis.* The contrasted aspect of the sculpture in the two forms is well illustrated in plate xiii. of Dr. Burckhardt's monograph, where figures of African and South American individuals are presented side by side.

* Lycett (3), p. 121 (1875). † Ibid., p. 210 (1879).

‡ Burckhardt (2), p. 72, pl. xiii., figs. 1, 2.

Another South American form which is probably also nearly related, is *Trigonia eximia* R. A. Philippi,* from the Tinguirica valley in Chili. This represents a type of shell very closely comparable with *T. conocardiiformis*, but the complete differentiation of the ribs into a posterior and an anterior series is a marked feature of the adult stage. With regard to this character of the ribbing, the form described by Burckhardt under the name *Trigonia* aff. *conocardiiformis* may be regarded as illustrating a somewhat intermediate type of sculpture between the two extremes, *T. conocardiiformis* and *T. eximia.* Another probably allied shell has been recorded by Haupt † from the Neocomian of Loteno, on the Rio Neuquen, on the east slope of the Argentine Cordillera, under the name *Trigonia* cf. *eximia* Philippi. This is said to differ from Philippi's type chiefly in having the dividing line between the anterior and posterior ribbing more obliquely directed. *T. eximia* is referred by Haupt to the section Undulatæ, but this is an obvious error. These aberrant forms in South Africa and South America have in common certain peculiar characters of shape and ornamentation by which they differ in marked manner from all divisions of the genus known to occur in the Jurassic rocks. It is not improbable that we are here dealing with representatives of several parallel series developed from some common ancestral species or group of species, showing rapid departure from the ancestral type along similar lines of development, the successive phases being attained, however, at an unequal rate. On the other hand, the possibility that convergence is illustrated is not remote. In the above description of *T. conocardiiformis*, differences observable in the plan of sculpture after the close of the neanic stage are ascribed to individual variation. I believe this to be sufficient to account for such differences, but the possibility is not excluded that in the Uitenhage beds, two very closely similar forms, undergoing parallel development, are present. It may be that those individuals which show some division of the ribbing into two distinct sets forming an angle with one another, at the beginning of the adult stage, illustrate a series which has passed through a stage similar to that represented in the adult *T. eximia*, and that this stage, with angularly disposed costate ornamentation, has become suppressed by tachygenesis and reduction. The entire absence of characters of sculpture which approach those of *T. eximia*, in the other individuals from Cape Colony, might probably be due to the same cause.

* R. A. Philippi (1), p. 76, pl. xxxiv., fig. 3.

† Haupt (1), p. 216.

TRIGONIA TATEI Neumayr.

1867. *Trigonia cassiope* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 158.

1881. *Trigonia tatei* M. Neumayr, in E. Holub and M. Neumayr, Denkschr. d. k. Akad. Wiss., Math.-Nat. Cl., Band xliv., p. 275, pl. ii., fig. 3.

Occurrence.—A very imperfect and ill-preserved fragment of a costate *Trigonia* occurs in hard limestone with *Pleuromya baini* from Grass Ridge, three miles east-north-east of Uitenhage (335). In all probability this represents *T. tatei.*

Remarks.—Although no complete or satisfactorily determinable specimens of this well-characterised form are included in the collection under examination, it may be useful to draw attention to one or two points of interest in reference to the occurrence of this shell, the only member of the section Costatæ hitherto found in the Uitenhage beds. In 1877, Lycett* cast doubt upon the correctness of Tate's identification of this South African form with the European Oolitic shells named *T. cassiope* by d'Orbigny,† and Neumayr subsequently saw the necessity of applying a new name. *T. tatei* certainly cannot be united with any other known costate form, and although the general outline and nature of the ribbed flank has a close parallel in several familiar European Costatæ, yet the narrow area and elongated escutcheon, the delicate and little-prominent carinæ and inter-carinal ridges, and the relatively very delicate beaded ornamentation of area and escutcheon, are very distinctive features.

Two specimens preserved in the collection of the Geological Society of London are labelled "Zwartkop River" (H. Longlands) and "McLoughlin's Rest" (Major Rocke) respectively, and the former specimen appears to have been the one upon which Tate's identification was based. The length is relatively great compared with the height; the cardinal margin is elongated, while the siphonal margin is short. The area is slightly convex in form, without a marked median carina or groove; the escutcheon is large, and ornamented by raised lines of granules running parallel to the ridges of the area. There are about 18 ribs on the flank of the larger specimen. The elongated form, the very delicate carinæ, the fine intercarinal sculpture, the convex area, and the elongated granular escutcheon, are all characters which at once recall the

* Lycett (3), p. 172. † d'Orbigny (4), vol i., p. 308.

same features in *T. tenuis*, from the Oomia beds in Cutch.* This, however, is strongly distinguished from *T. tatei* by the very crowded and delicate costate ornamentation of the flank, and by the slight convexity of the valve.

In view of the comparative rarity of the Costatæ in the Cretaceous rocks, the occurrence of so typical a member of the section in the Uitenhage Series might appear at first sight to lend some support to the view of those who have maintained that a part, at least, of these beds must be ascribed to the Upper Jurassic. It is clear, however, that in any attempt to uphold such a conclusion, less weight can now be attached to the presence of Costatæ than when our knowledge of the distribution of this division of the *Trigoniæ* was founded principally upon European occurrences. In Europe itself, representatives of the section are sparsely present in the Cretaceous, and these mostly show deviations which at once distinguish them from the typical Jurassic forms. *Trigonia peninsularis* Coquand,† from the Aptian of Spain, exhibits a marked degeneration of characters in its later growth-stages, while *T. carinata* Agassiz,‡ from the Neocomian and Aptian, which may be brought into the most intimate connection with the Costatæ, shows equally far-reaching modifications, although an examination of Lycett's figured specimens and other well-preserved individuals fails to reveal any characters which can be taken to justify Lycett's separation of this form under a separate sectional heading.§ The typical features of the section Costatæ are exemplified, however, in a small *Trigonia* described by E. Ascher from the Hauterivian of Silesia.||

Although these European forms may be looked upon as lingering representatives of a section which had passed its maximum development, we must look further afield in order to complete the history of this strongly characterised and long-lived division of the genus. In the marine Oomia beds of Cutch, which may now be regarded as of Lower Cretaceous rather than of Upper Jurassic age, aberrant derivatives of the Costatæ provide a striking feature in the molluscan fauna; but here also have been found two representatives, *T. tenuis* Kitchin and *T. parva* Kitchin, which retain in perfect manner the typical characters of the section. South America has also furnished another unmodified Cretaceous costate form in *T. anguste-costata*, described by Behrendsen ¶ from strata which he regards as Upper

* Kitchin (1), p. 35, pl. iii., figs. 5, 6. † Coquand (1), p. 129, pl. xxiii., fig. 3.

‡ Agassiz (1), p. 43, Tab. vii., figs. 7–10; Lycett (3), p. 179, pl. xxxv., figs 3–6, (1877). § See also Collot(1).

|| Ascher (1), p. 159 [25], pl. xiii. [ii.], fig. 10. ¶ Behrendsen (1), p. 6, pl. 3, fig. 7.

Cretaceous, at Caryilauhue (Argentine); this is accompanied by a typical member of the Cretaceous section Scabræ, *T. transatlantica* Behr. *T. anguste-costata* is a small triangular shell, which in the delicate character and close spacing of the flank-ribs recalls the Indian *T. parva* Kitchin, from which, however, it is widely distinguished by the very different outline and the delicate ornamentation of the area. In the perfect development of these longitudinal ridges of the area, *T. anguste-costata* retains in typical manner an essential feature of the section, a differentiation of the valve-sculpture which so strongly and constantly characterises all the Costatæ. With reference to the occurrence of the costate *Trigoniæ* in Cretaceous rocks, Behrendsen cites, in addition to *T. peninsularis* Coquand and *T. carinata* Agass., the following shells: *T. longa* Ag., *T. pennata* Sow., *T. cardissa* Ag., and *T. indica* Stoliczka. This list, however, is misleading, as may be ascertained from a careful examination of these forms. *T. longa* and *T. pennata* certainly cannot be included in the section Costatæ, while it is doubtful whether *T. indica* stands in very close connection with this division. *T. cardissa*, on the other hand, is a typical representative of the section, but it has been shown to be Jurassic,* and not Cretaceous, as at first suggested on insufficient grounds by Agassiz.

Genus CARDITA J. G. Bruguière.

Cardita nuculoides Tate.

Plate VII., figs. 5, 5*a*, 5*b*.

1867. *Cardita nuculoides* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 162, pl. vii., figs. 7*a*–7*d*.

Occurrence.—Tate's figured specimen, numbered 11028 in the collection of the Geological Society, came from the Sunday's River. A specimen obtained by Mr. Rogers is from the left side of the Coega Valley, half a mile down from the railway (466g).

Remarks.—The specimen found by Mr. Rogers is a well-preserved left valve which differs slightly in outline from Tate's figured type: it is a little more drawn out obliquely, and the convex fold of the valve which runs obliquely from the umbonal region to the postero-ventral corner is rather more pronounced than in the original type. Tate's specimen, however, although having both valves in place, is not so perfectly preserved, and some allowance may also be made for individual variation. The general form of the shell,

* Bigot (1), p. 292.

and the complete agreement in the sculpture, leave no doubt that the specimen from Coega Valley must be identified with *C. nuculoides.*

The form of the shell is that of a four-sided figure with rounded angles. The anterior margin is short, the posterior margin, on the other hand, very extensive. The umbonal region is relatively weakly developed. The surface is beautifully ornamented by numerous, minute, radial striæ which cannot be seen with the naked eye. The intercrossing of the striæ with concentric growth-lines results in a delicate cancellation.

Genus ASTARTE J. Sowerby.

Astarte longlandsiana Tate.

1867. *Astarte longlandsiana* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 158, pl. viii., figs. 5*a*, 5*b*.

Occurrence.—Specimens in the collection of the Geological Society are from the Zwartkop's River. Mr. Rogers obtained an immature example of this form in the Coega Valley east of the railway, one mile up the line from Coega station (477g).

Remarks.—The immature specimen from the Coega Valley measures only 19 mm. in height. It has both valves in position, and the umbonal region of the right valve is perfectly preserved. The umbo is acutely pointed and is ornamented by closely spaced concentric ribs up to the apex. Tate says that the valves are ornamented with "slightly elevated ridges of growth," but it would be more correct to say that the ornamentation consists of well-raised concentric ribs. The ribs show some little irregularity of spacing. The surface between the rib-summits frequently shows finer concentric lines, which appear here and there to have the regularity of definite sculpture, though in places they resemble ordinary ridges of growth. The escutcheon is narrow, steep-sided, and deeply excavated, and the ribs of the flank terminate abruptly at the acute margin which bounds the escutcheon.

Sub-genus ERIPHYLA F. Stoliczka (? W. M. Gabb).

Astarte (Eriphyla) herzogi (Goldfuss).

1840. *Cytherea herzogii* (Hausmann) A. Goldfuss, Petrefacta Germaniæ, Band ii., Lief. 7, p. 239, Tab. cxlix., fig. 10.

1843. *Astarte capensis* F. Krauss, Amtlicher Bericht über die zwanzigste Versammlung der Gesellsch. deutsch. Naturforscher und Aerzte zu Mainz im Sept., 1842, p. 130.

1850. *Astarte herzogii* F. Krauss, Nov. Act. Acad. Cæs. Leop.-Carol. Nat. Cur., vol. xxii., pt. 2, p. 447, Tab. 47, figs. 2*a*–2*e*.

1905. *Astarte herzogi* A. W. Rogers, An Introduction to the Geology of Cape Colony, p. 291, fig. 25 (1).

Occurrence.—Specimens before me are from the uppermost red bed in a kloof east-north-east of Red House on Zwartkop's River (326, 327), and from a krantz near Picnic Bush, north-east of Red House (328). Messrs. Rogers and Schwarz also found this shell in the cutting on the road running from the farm Perseverance on to the plateau, and leading to the Salt Pan. Stow obtained specimens at McLoughlin's Bluff and between the Addo and Modder Drifts, on the Sunday's River. Hertzog's collection, including this shell, was obtained in the Sunday's River district about eighteen miles from Enon.* Krauss collected specimens on the left bank of the Zwartkop's River, below Uitenhage.

Remarks.—Krauss furnished such an accurate description of this shell that it will only be necessary to supplement this by a discussion of its narrower relationships. *Astarte herzogi* cannot be looked upon as a typical representative of its genus, and it is by no means a simple matter to assign it to its correct position among recognised sub-generic groups. The principal characters to be borne in mind in this connection are as follows. The shell has a lenticular form and frequently an almost circular outline; it is ornamented by crowded concentric ribs and sulcations forming a well-developed sculpture. The lunule is short, but is sharply bounded and of very deep and concave form; the escutcheon is very narrow and elongated, almost entirely occupied by the long ligament space, and very sharply marked off from the flank. In the right valve there is a distinctly developed posterior lateral dental process, situated behind the elongated external ligament, and an anterior (sub-lunular) depression in the hinge-plate for the reception of an anterior lateral process of the left valve. The pallial margin of the valve is strongly notched on its inner side; the pallial line is posteriorly rather weakly impressed.

We are therefore dealing with an *Astarte* in which lateral hinge processes are definitely developed. The evidence for the presence or

* See Hausmann (1), p. 1459 (as *Cytherea*).

absence of a shallow pallial indentation, it must be admitted, is inconclusive in the material I have examined, but this, after all, is a comparatively minor point, and one of less importance than the nature of the hinge. A fact to be noted is that shells which exhibit a similarly developed hinge are chiefly characteristic of Cretaceous rocks in other regions.

Stoliczka* thought that *Astarte herzogi* belonged to Speyer's genus *Grotriania*,† but in reality it is widely enough removed from this, which has a very different form and is characterised by a very large and profoundly excavated lunule and escutcheon, and by the absence of lateral teeth. Much closer agreement is shown to the shells known as *Eriphyla lenticularis* (Goldfuss) ‡ and other forms to which the name *Eriphyla* has been applied. Unfortunately, the employment of this name has been attended with some confusion. The shell upon which Gabb founded the name (*E. umbonata* Gabb)§ occurs in the Shasta-Chico Series of California,|| and it was thought to be allied to *Astarte*. The characters of the shell were unfortunately not diagnosed with satisfactory precision, and Stoliczka¶ first stated in full detail the distinguishing features of Cretaceous shells (*E. lenticularis*) which he believed to be generically identical with *Eriphyla umbonata* Gabb. Stoliczka, however, brought the genus into relationship with *Dosinia*, though he adduced no convincing reason for such a view, except the presence of a pallial sinus. His description of the hinge characters shows that they agree with those of *Astarte herzogi*, but he mentioned the pallial sinus as a leading feature of his shells, and made no reference to any crenulation of the margin. He says: "It appears probable that some of the Jurassic *Astarte* (*A. excavata* and others) belong to this genus, but a careful examination of the hinge and of the pallial line, which is broad though very faint, and also of its sinus, will be necessary." Again, he remarks: "The hinge-teeth of *Eriphyla* closely approach those of *Astarte*, but these have no distinct lateral teeth, nor a deep lunule or sinus."

Whether Stoliczka did right in ascribing the widely distributed *E. lenticularis* to Gabb's imperfectly characterised genus is a question which still remains unanswered. He, at any rate, used the name in connection with definite and precise diagnostic characters, and his reading has been accepted by Holzapfel,** who maintains

* Stoliczka (2), p. 286 (1871). † Speyer (1), p. 496, Taf. xi., fig. 6.
‡ Goldfuss (1), Band ii., p. 228, Tab. cxlvi., fig. 16 (1837).
§ Gabb (1), p. 180, pl. 24, fig. 162. || See Diller and Stanton (1).
¶ Stoliczka (2), p. 156 (1870). ** Holzapfel (1), p. 196.

that so long as it cannot be shown that *Eriphyla* Stoliczka differs in essentials from *Eriphyla* Gabb, this name must be retained for shells having the characters set forth by Stoliczka. Previously, however, J. Böhm * had remarked upon the unsatisfactory nature of Stoliczka's use of Gabb's name, in view of the great uncertainty respecting the characters of the Californian shell, and he employs the name *Dozyia* for *Lucina lenticularis* Goldf., a name applied by Bosquet in 1868 to the same form. Meek † also doubted the correctness of Stoliczka's view in identifying the European and Indian shell with Gabb's genus, but his remarks on the subject only add further confusion and help to show the futility of attempts to utilise Gabb's imperfect description and figure in a generic characterisation.

From the foregoing it appears clear to me that in the absence of further information regarding the Californian type, the published account of Gabb's genus is totally insufficient to support the validity of the name proposed by him; the repeated attempts to utilise Gabb's description and figure have proved so unavailing that the name as based upon Californian material may be reasonably ignored. In further support of this contention it is only necessary to mention that Whitfield ‡ has so conceived the meaning of Gabb's description as to apply the name *Eriphyla* to a Cretaceous shell from Syria which is characterised by triangularly elliptical outline, strongly prominent umbonal region, a short *internal* ligament, and surface sculpture resembling that of *Chione*.

The question then arises, whether the name *Eriphyla* as defined by Stoliczka may be applied to *E. lenticularis*, in view of the fact that Bosquet had previously proposed to call this *Dozyia lenticularis*. It is true that this generic name was only published in a tabular list, § without description or discussion, but it was accompanied by a reference to Goldfuss's type. I should have no hesitation in following Dr. J. Böhm and employing Bosquet's name on the strength of the definite reference to Goldfuss, but unfortunately the description and figure given in the "Petrefacta Germaniæ" deals only with external characters, and no mention was made of those features which are of generic or sub-generic value. These were first elucidated by Stoliczka, and herein lies the justification for following Prof. Holzapfel in accepting the name *Eriphyla*, as defined by Stoliczka.

Eriphyla lenticularis has a shallow pallial sinus and its valve-margins are not crenulated. It might therefore appear that, on the

* J. Bohm (1), p. 125.
† Meek (2), p. 123.
‡ Whitfield (1), p. 403, pl. vi., figs. 2–5.
§ Dewalque (1), p. 368.

strength of these points, *Astarte herzogi* should be excluded from this division of the genus, though in reality these characters are of very small value and appear to be sufficiently inconstant to be discarded as guides to the sub-generic grouping. The hinge-characters above described, on the other hand, are remarkably constant in several Cretaceous forms which differ in regard to the marginal crenulation, and it appears that the posterior indentation of the pallial line is only of specific value at the most, appearing occasionally, as in a few other "integripalliate" genera. A shallow pallial sinus is shown to be present in the figures of Aptian shells ascribed by Pictet and Renevier* to *Astarte buchi* F. Roem. and *A. obovata* J. Sow., and in both of these the margin is crenulate. *Astarte striata* J. de C. Sow., from the Blackdown Beds of England, shows very close agreement with *E. lenticularis*, and, like it, has a shallow sinus and a smooth margin. Then again, the same shell agrees closely in the hinge and other features with *Astarte herzogi*, though the latter has a crenulated margin. This last character, indeed, is clearly one of very small significance. In dealing with *Astarte* and its divisions, von Zittel † has ignored the notching of the margin, while several authorities on the living forms have abandoned this structure as even of specific value.‡ Regarding the value of the distinctive characters of *Eriphyla*, as here accepted, in establishing its claim to the rank of a separate genus, opinions may be expected to differ; I am not convinced that a definite separation from *Astarte* is expedient, or warranted by the features which distinguish *Eriphyla* from typical members of that genus, and I therefore prefer for the present to follow Zittel in employing the name *Astarte* in the broad sense, and including *Eripyhla* as a sub-genus.

In tracing the relationships of *A. herzogi*, it is somewhat surprising to find that the closest agreement is exhibited with shells from the Neocomian of Lincolnshire. These occur in the Claxby Ironstone at Willingham and Benniworth Haven, and are most probably to be assigned to a horizon comparable with a part of the zone of *Belemnites lateralis* or possibly the lowest part of the zone of *Belemnites jaculum* at Speeton; § specimens are preserved in the Museum of Practical Geology in London, and in the Sedgwick Museum at Cambridge, and have been identified by Mr. Woods as *Astarte lævis* (Phill.).|| The similarity to *A. herzogi* is striking, but the following

* Pictet and Renevier (1), pl. x., fig. 1; xi., fig. 1.

† Zittel (5), p. 65.

‡ See Jeffreys (1), p. 309.

§ Pavlow and Lamplugh (1), p. 29 (of authors' copy); Pavlow (1), able, p. 548.

|| Woods (3), vol. ii., p. 115 (1906).

points of distinction appear to be constant and to justify the definite separation of these two forms. In the Lincolnshire specimens the shell is as a rule less orbicular, and attains greater height in proportion to length; at the same time, the valve is rather more flattened towards the inferior margin in fully grown individuals. The lunule has greater relative length and is less deeply excavated and less concave in form than in *A. herzogi.* The noticeable fact that the sculpture in the Lincolnshire examples is less well defined than in the African shell may perhaps be in some measure due to the mode of preservation. The form and size of the lunule certainly affords a good separating character, and as regards the outline of the shell, the difference above mentioned seems to hold good if specimens of average proportions be compared, though it must be admitted that *Astarte herzogi* exhibits considerable shape variation, and specimens with shorter and higher outline occur not infrequently.

As already remarked, *Astarte striata* Sow.,* from the Blackdown Beds, agrees in many respects, but it is a much more compressed and flattened shell, has greater length in relation to height, and shows no marginal crenulation.

Astarte beaumonti Leym.,† from the Neocomian of the Aube, is likewise characterised by a sharply demarcated and deeply excavated lunule, and is ornamented by ridges and sulcations similar to those of *A. herzogi;* it may probably agree, too, in the internal characters, but it differs by its inequilateral form and oblique elongation.

Astarte buchi F. Roemer ‡ (Lower Cretaceous, Perte du Rhône) seems to agree well in internal characters, though it is not clear whether a posterior lateral tooth of the right valve is plainly developed. The sub-lunular groove in the hinge of the right valve, shown in Roemer's figure, seems to indicate the presence of an anterior lateral tooth in the left valve. The sharply cut, elongated escutcheon and the well-sunk short lunule are similar, but Roemer's shell differs from *A. herzogi* by being considerably more inequilateral in shape and also less incurved at the umbones, besides having much less perfectly developed concentric surface sculpture.

Astarte sæmanni de Loriol, from the Portlandian of the north of France § and of England,|| is more similar again, and may be closely

* J. de C. Sowerby (1), vol. vi., Tab. 520, fig. 1 (1826).

† Leymerie (2), p. 4, pl. 4, fig. 1.

‡ F. Roemer (1), p. 20, fig. 4.

§ De Loriol and Pellat (1), p. 68, pl. vi., fig. 9.

|| Blake (1), p. 232, pl. x., fig. 5.

related. The ornamentation, though coarser, with broader and more widely spaced ribs, is of essentially the same kind, and there is the deeply cut lunule. It may be judged from de Loriol's figure of a left valve that a posterior lateral hinge process is present in the right valve. The shell, while appearing to have very closely similar hinge characters, differs from *A. herzogi* by its more elongated form and relatively less height. English specimens from the Portland Sands of Swindon, ascribed to *A. sæmanni*, have a denser costate ornamentation than the example figured by de Loriol, and in this they more closely resemble *A. herzogi*. Miss E. G. Skeat has drawn attention to the fact that these English specimens, which are well represented in the Sedgwick (formerly Woodwardian) Museum at Cambridge, exhibit a shallow pallial sinus.*

A shell described by G. Müller under the name *Eriphyla stuhlmanni*, from the Neocomian at a locality 35 km. west of Mtshinga in German East Africa,† clearly belongs to the same sub-generic group. In the characters of the hinge and in the presence of marginal crenulation, it resembles *A. herzogi*, but differs by the absence of the surface ridges and sulcations and by the more inequilateral form and more prominent umbones. *Eriphyla stuhlmanni* is accompanied by a *Gervillia* probably identical with *G. dentata* Krauss. Dr. Müller refers his shell to *Eriphyla* without comment, and was no doubt influenced by the presence of the lateral teeth.

In the orbicular outline, the surface ornamentation and the type of hinge, *Astarte jugosa* (Forbes)‡ from the Upper Cretaceous of the Trichinopoly district (Utatur stage) approaches somewhat closely to *A. herzogi*. The Indian shell was referred by Stoliczka§ to Speyer's genus *Grotriania*, but this was an error of judgment. Its valves, it is true, have a somewhat deepened lunule and escutcheon, but do not compare in this respect with those of the true *Grotriania*, and, moreover, have plainly developed lateral hinge-processes fitting into opposing grooves. In this respect *A. jugosa* agrees with *A. herzogi*, and may be classed in the same sub-division of *Astarte*. According to the description and figures given by Stoliczka, it has a crenulated valve-border and the pallial line is without a sinus. The shell differs from *A. herzogi* by the greater compression of the valves, the greater depth of the escutcheon and hinge-plate, and the more nearly circular outline.

* Skeat and Madsen (1), p. 124.

† G. Muller (1), p. 553, Taf. xxi., figs. 3, 4; Taf. xxii., figs. 8–10.

‡ Forbes (2), p. 142, pl. xvii., fig. 7.

§ Stoliczka (2), p. 289, pl. x., figs. 12–14.

Eriphyla argentina Burckhardt,* from the Neocomian of Las Lajas (Argentine), is also a similar shell, as regards the hinge, the deep lunule and escutcheon, and the development of concentric ornaments. It differs, however, from *A. herzogi* by the considerably more elongated figure and the coarseness and spacing of the ornamenting ridges. *E. argentina*, it may be observed, has a weak pallial sinus, and Dr. Burckhardt remarks that the margin is probably crenulated.

Astarte (Eriphyla) pinchiniana Tate.

Plate VII., figs. 6, 6*a*.

1867. *Astarte pinchiniana* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 157, pl. ix., fig. 7.

Supplementary Descriptive Note.—The shell has a sub-orbicular outline, with rather acutely pointed, anteriorly directed umbones. The lunule is sharply demarcated from the flank, and is of deeply excavated form, bounded outwardly by a sharp ridge which is concave in profile. The lunule is of relatively great length. The escutcheon is narrow, deep, and sharply bounded, and is occupied very largely by the ligament space.

The valve-surface is ornamented during the neanic stage by numerous and closely crowded, very regular and delicate concentric ribs, terminating posteriorly at the margin of the ligament-space. This ornamentation becomes obscure at a distance of 3–5 mm. below the umbo, and subsequently gives place to numerous delicate, raised growth-lines, too irregular to be confounded with definite sculpture. Stronger ridges and furrows of accretion appear in the late adult stage.

The shell-substance is very thick in relation to the size of the specimens. The interior of the valve-border is strongly crenulate.

Dimensions.—	(1)		(2)		(3)
Height, measured from the umbo	15	.	18	.	18 mm.
Length	15	.	18·5	.	19 ,,
Depth of a single valve	3·5	.	5	.	4 ,,

Number (3) is the specimen figured by Tate.

Occurrence.—Collected by Miss Wilman at Coega River. The specimens in the collection of the Geological Society in London are from the Sunday's River.

Remarks.—Tate's description and figure of this elegant form must appear sufficiently inadequate when it is realised that a most dis-

* Burckhardt (2), p. 76, pl. xii., figs. 3–6.

tinctive feature is the very elongated, sharply demarcated and deeply excavated lunule, well preserved and exhibited in the specimen unsatisfactorily figured by Tate. The widely erroneous statements of shell-measurements, so numerous in that author's paper on the South African fossils, are difficult to account for and may best be ignored. Tate's comparison of *A. pinchiniana* with two English Oolitic forms, *A. excentrica* Morr. and Lyc. and *A. pumila* J. de C. Sow., is also unfortunate, since a very much closer resemblance is shown to several Cretaceous forms. *A. excentrica* * is much more triangular in outline and has the lunule scarcely defined, while *A. pumila* † is a narrow, convex, inequilateral shell widely different in type from the one we are considering.

The question whether *A. pinchiniana* should be referred to the subgenus *Eriphyla*, as defined by Stoliczka, cannot be decided by an examination of the material which has been at my disposal. In no instance have I been able to ascertain the characters of the hinge, and it is therefore uncertain whether lateral hinge-processes are present in either valve. At the same time, the external characters of shape and the presence of a deep and sharply defined lunule, suggest the strong probability that the arrangement of hinge and lateral teeth is the same as in *Eriphyla*, but it would, of course, be unwise to accept close agreement in external features as justification for a definite conclusion on this point. For the time being, a provisional reference to *Eriphyla* may be permitted. This question might seem to be of subsidiary interest were it not that the known characters of *A. pinchiniana* give this shell so close a resemblance to members of a principally Cretaceous group of forms, and as additional evidence for the age of this fauna, such resemblance must be taken fully into consideration. Remarks on the application of the name *Eriphyla* in dealing with certain Cretaceous forms of *Astarte* will be found above in the discussion concerning the relationships of *Astarte* (*Eriphyla*) *herzogi*.

A. pinchiniana differs from immature examples of *A. herzogi* by the relatively more extended lunule and the disappearance of concentric sculpture at the close of the neanic stage. It bears a great outward resemblance to immature specimens of *A. striata* Sow.,‡ having a similarly elongated lunule, with the marginal profile of concave form in front of the umbo; but in *A. pinchiniana* the concentric surface

* Morris and Lycett (1), part iii., p. 83, pl. ix., fig. 8 (1855).

† J. de C. Sowerby (1), vol. v., Tab. 444, fig. 2 (1824).

‡ Ibid., vol. vi., p. 35, Tab. 520, fig. 1 (1826).

ridges are absent in the adult, and the interior of the valve-margin is strongly crenulated.

Astarte rhodani Pict. and Camp.,* from the "Gault" of the Perte-du-Rhône, is of similar general type, but is truncated posteriorly. Shells from the Gault of Cosne (Nièvre) figured by de Loriol† under the name *A. rhodani* have a much more closely similar, rounded outline; they appear, however, to have a slightly shorter lunule, and they are probably without marginal crenulation.

Astarte dupiniana d'Orb.,‡ from the Albian of France, closely resembles *A. rhodani* Pict., and like this, is abruptly truncated posteriorly; in this it offers a contrast to the more rounded profile of *A. pinchiniana*. *A. dupiniana* possesses the character of marginal crenulation, but differs from the African shell in having a less strongly developed lunule and escutcheon.

The presence of well-developed sculpture in the neanic stage of *A. pinchiniana* and its disappearance in the succeeding growth-stages, indicates degeneration, so far as this character is concerned, from a wholly sculptured ancestry.

Genus ANTHONYA W. M. Gabb.

Anthonya lineata sp. nov.

Plate VII., figs. 7, 8.

Description.—The shell is of slender, elongated form, much produced posteriorly. The valves are flattened and compressed, having very slight convexity. The umbonal region is not strongly prominent; it is situated at a distance of about one-third of the shell's total length from the anterior extremity, where also the shell has its greatest height. The upper valve-margin, posteriorly to the umbo, slopes down gradually, giving a very slightly concave outline. It has an angular junction with the siphonal margin. The siphonal margin is very short and shows a straight outline, directed slightly posteriorly when traced down to its inferior termination. In front of the umbo, the valve-margin is at first forwardly produced with a downward slope and straight outline, passing then by a curve into the convex anterior margin. This in turn passes by regular curve into the elongated, slightly convex inferior margin. The siphonal

* Pictet and Campiche (1), 3e Partie, p. 319 (1866); Pictet and Roux (1), p. 437, pl. 32, fig. 5 (1852).

† de Loriol (4), p. 94, pl. xii., figs. 1–7.

‡ d'Orbigny (3), p. 70, pl. 264, figs. 4–6 (1844).

margin marks the posterior limit of a weakly defined postero-superior area of the valve-surface. This is only demarcated from the flank by a weak and flattened fold of the surface which passes obliquely backwards from the umbo to the postero-inferior angle of the valve.

The ornamentation consists of very delicate, closely spaced, rounded, concentric ridges, separated by impressed linear interspaces. The ridges traverse the flank, parallel to the pallial border, then turn sharply upwards to cross the area in a direction parallel with the siphonal border. On the area the ornaments are slightly coarser and less regular, and less strongly developed than on the flank.

An internal cast of a left valve shows traces of very weak rounded ribbing, running parallel to the inferior border, but these markings are confined to the middle part of the valve and terminate posteriorly at the oblique, weak carinal ridge. In addition to the two short, diverging, cardinal teeth, there are indications of a narrow, lath-like ridge (represented on the cast by a narrow hollow) running parallel with the upper valve-margin for a short distance in front of the umbo, and another similar narrow depression extends for a longer distance close to the valve-margin behind the umbo. Just above the posterior part of the broadly oval anterior adductor impression, is a small, well-marked, oval pedal muscle-scar. The somewhat elongated posterior adductor impression is situated close to the upper valve-border, half-way between the umbo and the posterior margin, and just below the narrow, lath-like process which is represented on the cast by a groove close to the valve-margin. The pallial line on reaching its posterior extremity turns sharply forward with an angular bend.

Dimensions.—	(1)		(2)
Length	15	.	22 mm.
Greatest height	8	.	12 ,,

Occurrence.—Specimen (1), preserved as a mould of the external surface of a left valve, was found on the left side of the Coega Valley, half a mile down from the railway (461g). Specimen (2), which is the cast of the interior of a left valve, came from a bare slope W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop, Sunday's River (35h).

Remarks.—There can be no reasonable doubt that the two specimens above described, showing the exterior and interior characters respectively, belong to one species. They are of interest as representing a genus of shells which is elsewhere only known to occur in rocks of Cretaceous age. These valves have a very delicately

shaped, flattened form, and though their depth cannot be satisfactorily measured in either specimen, it could not have exceeded two or three millimetres. In the example from Olifant's Kop, the pallial border does not lie in a median plane of symmetry, but is laterally bowed, with a slight convexity towards the observer. This may possibly have been an individual abnormally distorted in life, or the distortion may perhaps have been brought about during the process of fossilisation, but it was probably not a normal character.

Anthonya cultriformis Gabb,* the type-species of the genus, from the Cretaceous rocks of California, differs in being considerably more elongated and attenuated posteriorly, and in having more oblique posterior truncation. It also lacks the close linear ornaments which cover the whole surface of *A. lineata*, though it has a similar type of sculpture in the umbonal region.

A. cantiana Woods,† from the Folkestone Beds of Folkestone, is more inequilateral, with the umbonal region more elevated and nearer to the anterior extremity. A species described by Mr. Woods, though unnamed, from the Lower Greensand of Atherfield, is distinguished by the posterior elongation and attenuation of its shell, and by its smooth surface.

Anthonya cornueliana (d'Orb.) ‡ appears to approach more closely in form, especially such a specimen as that figured by Miss Skeat; but *A. lineata* is less inequilateral and is not so obliquely truncated posteriorly.

Genus TANCREDIA J. Lycett.

Tancredia schwarzi sp. nov.

Plate VII., figs. 9, 9*a*, 10.

Description.—The shell has an elongated trigonal outline, well produced anteriorly. The umbonal region is prominent, the margin before and behind it falling away rapidly. The umbo is situated within the posterior half of the valve, though not distant from the middle; it is fairly strongly incurved. The upper margin in front of the umbo forms a straight line in profile, and only curves on reaching the anterior extremity, where it passes by a sudden and sharp bend into the long, gently convex inferior margin. At the posterior end of the short, straight hinge-line the shell-outline is obliquely

* Gabb (1), p. 182, pl. xxx., fig. 236.

† Woods (3), vol. ii., part 3, p. 130, pl. xix., figs. 4, 5 (1906).

‡ d'Orbigny (3), p. 74, pl. cclxiv., figs. 7–9 (1844), described as *Crassatella;* Skeat and Madsen (1), p. 178, pl. vi., fig. 13 (as *Ptychomya*).

truncated. The oblique posterior border has a sub-angular junction with the inferior border. The greatest height occurs at the umbo. The valves are weakly inflated, most strongly so posteriorly to the middle, and are anteriorly compressed and flattened.

On the posterior side of the valve, a well-marked carinal ridge extends obliquely backwards from the umbo to the posterior angle of the shell, cutting off a narrow, flattened area from the flank. Near the umbo, the surface of the area is directed at right angles to that of the flank, but the angle becomes more obtuse when traced towards the posterior end of the valve. The surface of the area is slightly concave in the neighbourhood of the umbo, but becomes flat posteriorly. The surface of the flank close to the antero-superior margin curves over with a convex surface towards the margin. The surface of the valves is marked only by occasional faint growth-lines.

Immature specimens have a rather more pointed anterior outline than an individual of larger dimensions.

Dimensions.—	(1)		(2)		(3)
Length	16	.	16	.	22 mm.
Height, measured from the umbo	10	.	11	.	15 ,,
Greatest depth of a single valve	4	.	4	.	5 ,,

Occurrence.—In the kloof east-north-east of Red House, on the left side of the Zwartkop's River (324); this form is also found in the Marine Beds of the Sunday's River, where it occurs associated in the same hand-specimen with *Trigonia vau*, *Trigonia conocardiiformis*, *Actæonina atherstoni*, and other characteristic shells. A specimen of this kind is from the collection of the South African Museum. Mr. Rogers collected a fine example of this form from a cliff W. 20 S. from Comley's house, right bank of Sunday's River (95h).

Remarks.—The specimens examined are unfortunately so preserved in hard matrix that it has been found impossible to investigate the internal characters. The outward features of the shell, however, are so well marked and so characteristic, that one can scarcely suggest a doubt as to the generic position, unless, indeed, it should happen that we are dealing with a striking instance of parallelism, of which there is so far no evidence. It is with Jurassic forms that the most striking similarities are shown.

This shell may be most aptly compared with familiar English Oolitic forms. *T. extensa* Lycett,* from the Inferior Oolite, is very

* Lycett (1), pl. xi., fig. 9; Morris and Lycett (1), part iii., p. 93, pl. xiii., fig. 6 (1855).

similar in outline, but differs in having the umbones more centrally placed, and the posterior carinal ridge less prominently developed and less steeply inclined. The posterior area is narrower, and this and the carinal ridge have greater relative length than in *T. schwarzi*. In the African shell the umbonal angle is sharper and the umbonal region more prominently projecting.

Tancredia brevis Lycett,* from the Great Oolite, is also closely similar in form, and may be distinguished principally by its slightly greater convexity, its less prominently projecting umbonal region, and its more pointed anterior outline.

Again, the resemblance shown by *T. schwarzi* to *T. angulata* Lycett,† from the Great Oolite, is very close, particularly in the position of the umbones, the long antero-superior slope of the outline, and the inclination of the carinal ridge ; in *T. angulata*, however, the outline is rather more obtuse at the posterior angle, and the aspect of posterior truncation is more marked, while the anterior outline has a rather more pointed form. The resemblance of *T. schwarzi* to these Jurassic types is indeed so striking as necessarily to arrest attention, and it is clear that such a form, if known before, would have been seized upon by those who believed the Uitenhage fauna to be of Oolitic age. How little reliance should be placed on the evidence of a single occurrence such as this is well shown by a study of the associated types, which can only be taken to indicate the Lower Cretaceous age of this fauna. Although the genus *Tancredia* reached its greatest development during Jurassic times, *T. americana* Meek and Hayden ‡ is known from Cretaceous strata on the Upper Missouri and on Cache La Poudre River, in Colorado. The generic position of *T. americana* has not been disputed, so far as I am aware, but it is a much larger shell, not closely comparable with the one we are discussing.

A shell from the Upper Aptian of Spain, described by Coquand § as *Tellina gibba*, bears considerable resemblance to some forms of *Tancredia*, and may very well be a representative of this genus, though Stoliczka suggested that it belongs to Gray's *Tellinella*. Coquand himself stated that it differs from other fossil *Tellinæ* by its elongated form and particularly by the strong carinal ridge. Speaking generally, this shell shares the main outward characters of

* Morris and Lycett (1), part iii., p. 92, pl. xiii., fig. 8 (1855).

† Lycett (2), 341, pl. xiv., fig. 5 ; Morris and Lycett (1), part iii., p. 94, pl. xiii., fig. 9 (1855).

‡ Meek (2), p. 142, pl. 38, fig. 1.

§ Coquand (1), p. 101, pl. viii., figs. 9, 10.

Tancredia schwarzi, from which it differs by its greater elongation and relatively reduced height; it has a more obtuse umbonal angle, and the umbonal region is consequently considerably less prominent.

Although there is also some resemblance to shells which have been ascribed to the genus *Palæomya* Zittel and Goubert,* *Palæomya deshayesi* Zittel and Goub., from the Corallian, upon which the genus was established, is a more elongated shell and is more inequilateral and less definitely carinated posteriorly. Its umbonal angle is also very much more obtuse. *Palæomya autissiodorensis* (Cott.) de Loriol,† from the Portlandian of the Yonne, while more equilateral and more sharply carinated than the last, is also relatively much more elongated than the African shell, and has much less sloping upper outlines, with inconspicuous umbonal region and obtuse umbonal angle. It may be noted that Miss E. G. Skeat ‡ has referred this Portlandian shell to the genus *Tancredia*, and expressed the belief that these supposed separate genera may have to be united; she points out that they appear to agree very closely both in external and internal characters.

Genus THETIRONIA F. Stoliczka.

Thetironia papyracea (Sharpe).

Plate VII., figs. 11, 11*a*.

1856. *Ceromya papyracea* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 195, pl. xxii., fig. 8.

Supplementary Description.—The shell is of rounded sub-quadrate or oblong outline, with the length slightly greater than the height; it is strongly inflated in the umbonal half. The umbones are strongly incurved and are anteriorly directed; they are situated at a distance of less than one-third of the shell's total length from the anterior margin. The hinge-line is only very slightly curved and has a scarcely perceptible downward slope when traced backwards from the umbo, passing posteriorly by a somewhat abrupt curve into the elongated posterior margin; this margin, also, is only very slightly convex in profile and gives the shell an aspect of vertical posterior truncation. The lower border forms a gently convex profile. There is no keel on the posterior side of the valve.

The surface of the very thin shell is ornamented by numerous,

* Zittel and Goubert (1), pl. viii., figs. 6–8.

† de Loriol and Cotteau (1), p. 510, pl. v., figs. 12–14.

‡ Skeat and Madsen (1), p. 129.

delicate, radial, linear striæ, which at the lower margin of an adult, and especially in the posterior half of the valve, may be separated by spaces exceeding a millimetre in breadth. The granular ornaments which occur on the striæ are delicate though prominent, and widely spaced (nearly 4 mm. apart on the same radial line) towards the lower margin in the posterior half of the valve, but less conspicuous and much more closely spaced in the anterior half.* The radial striæ leave their impression on the cast when the thin shell becomes removed.

The well-impressed line on the posterior side of a cast, passes far up and has its angular apex situated close to the umbonal apex. Its anterior limb becomes weakly impressed when traced downwards from the angle for a distance of 7 mm. or 8 mm., and appears to dwindle and disappear at its lower end instead of bending forwards as a well-defined line. On the anterior side of the cast there is a single radial linear impression, less clearly defined than those of the posterior side; it appears most clearly marked at a distance of about 6 mm. from the umbonal apex, and dies out on entering the lower half of the valve.

Dimensions.—	(1)	(2)	(3)
Length	22 .	25 .	47 mm.
Height measured from the umbo	19 .	22 .	30 ,,
Greatest depth of a single valve ...	8 .	10 .	11 ,,

Number (3) is the specimen figured by Sharpe.

Occurrence.—Collected in the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the line from Uitenhage to Graaff-Reinet, about three miles from Uitenhage (315); also found by Miss M. Wilman at Coega. The locality given by Sharpe is "Zwartkop River."

Remarks.—Sharpe referred this shell with some doubt to the genus *Ceromya*, and he evidently had not the opportunity of observing the characters of the cast, which would have set at rest all doubts as to a generic determination. In addition to the well-impressed angular line on the posterior side of the umbonal region of the cast, the thin shell and the surface markings afford additional indications of generic position. In the fine specimen collected by Bain and figured by Sharpe, the shell is so preserved that the delicate ornaments of the surface are obscure, and their presence only becomes clearly evident when the specimen is very carefully examined in a good light under slight magnification. The specimen from Coega,

* It may, perhaps, be more correct to speak of some of these markings as punctations, each of which has a well-raised circular rim; they represent the bases of very short spines.

figured here, is so well preserved that these surface characters are plainly visible to the naked eye.

The occurrence of a representative of this exclusively Cretaceous genus has considerable interest when regarded as additional evidence for the age of this molluscan fauna. It is perhaps fortunate that the shell before us, when well preserved, is sufficiently characterised by its own distinctive form to preclude confusion with European members of the genus, especially as the nomenclature of these has for so long been in an unsatisfactory state. The European forms appear to show considerable variation, and are often preserved merely as casts, while the delicacy of the shell renders it liable to distortion, and true characters of similarity or difference are, therefore, often difficult to establish. In like manner, immature or ill-preserved specimens of *Th. papyracea* may seem to differ somewhat widely from the large individual figured by Sharpe, and may appear to approach some of the European forms; hence, a brief comparison with certain of these may perhaps be not without value.

The shells from the Blackdown Beds described under the name *Corbula lævigata* by Sowerby* seem to represent the same form as that afterwards named *Thetis major*,† while some shells from the Lower Greensand of Atherfield (Isle of Wight) cannot always be satisfactorily distinguished from small specimens of the Blackdown form. Others from the Lower Greensand in the Isle of Wight, named *Thetis minor* by the same author,‡ are frequently preserved as casts (the specimens from Shanklin), but appear to be usually well distinguished from those above-mentioned by their greater convexity, their more prominent umbones, and frequently straighter and longer hinge-line. Some individuals, however, are very difficult to separate, and Roemer§ united these two forms under the name *Thetis sowerbyi*. Forbes, again, divided Roemer's *Th. sowerbyi* into varieties *minor* and *major*;‖ but these are both regarded by Mr. Woods as synonymous with J. de C. Sowerby's *Thetis minor*. Mr. Woods also considers that d'Orbigny's *Thetis lævigata* is identical with Sowerby's *Th. minor*. Despite some difficulty in the comparison of certain individuals, we may on the whole satisfactorily distinguish between *Thetironia lævigata* (J. Sow.)—which includes *Th. major* (J. de C. Sow.)—and *Th. minor* (J. de C. Sow.), which includes *Th. lævigata* (d'Orb.)

* J. Sowerby (1), vol. iii., Tab. 209, figs. 1, 2 (1818).

† J. de C. Sowerby (1), vol. vi., Tab. 513, figs. 1–4 (1826).

‡ Ibid., vol. vi., Tab. 513, figs. 5, 6 (1826).

§ F. A. Roemer (2), p. 72 (1841). ‖ Forbes (1), 242.

Thetironia papyracea is distinguished from *Th. lævigata* by its greater inflation, its anteriorly situated umbones, its posterior truncation, and the absence of strong radial striæ on the posterior side in the neighbourhood of the cardinal margin. It is widely separated from *Th. minor* by its inequilateral form and long, truncated posterior margin, and apparently also by the obscure lower termination of the anterior limb of the angular line impressed on the cast.

The Cenomanian shell ascribed by d'Orbigny to *Thetis major*, which was renamed *Thetis rotomagensis* by Pictet and Campiche, is much more equilateral, and appears to have the umbonal region less prominent and less inflated than in *Th. papyracea*, and if d'Orbigny's figure be correct, the angular line on the cast does not extend so far up towards the umbonal apex. The anterior limb of the line is also bent forwards at its lower end and passes in well-defined manner across the flank.

Thetironia renevieri (de Loriol),* from the Hauterivian of Sainte-Croix and Mont Salève, has a general outline and degree of convexity somewhat approaching that of *Th. papyracea*, but the Swiss shell has the limbs of the angular line of the cast much more widely diverging, and the anterior limb forwardly bent and passing relatively closely to the anterior valve-margin when traced downwards; it is also more equilateral, with much greater height in relation to length.

Thetironia genevensis (Pict. and Roux), † which occurs in the "Gault" of the Perte-du-Rhone, Cosne, Sainte-Croix, and other places, is distinguished by its more equilateral and more circular outline, and by the form of the angular line on the cast, though it approaches *Th. papyracea* in its inflation and in the prominence of the umbonal region. *Thetironia prestensis* (Pictet and Campiche) ‡ (Aptian) lacks the elongation and posterior truncation that characterises *Th. papyracea*, and its linear markings on the cast follow a widely different course.

Thetironia sanctæ-crucis (Pict. and Camp.) is still further removed from the African shell, not only by its outline, but especially by the great relative breadth and shallowness of the posterior sinus on the cast.

A shell which much more closely approaches *Th. papyracea* in the general form and outline and in the position of the umbones is

* de Loriol (1), p. 65, pl. ix., fig. 11.

† Pictet and Roux (1), p. 420, pl. xxx., fig. 2 (1852).

‡ Pictet and Campiche (1), 3e Partie, p. 205, pl. cxii., fig. 6 (1865).

Th. caucasica (Eichwald),* from "Greensand" in Daghestan, said to be of Gault horizon. When compared with other representatives of the genus, this, like the African form, is of relatively elongated outline; but in *Th. caucasica* the shell is slightly more equilateral and the posterior border is not so abruptly truncated as in *Th. papyracea*, but is more convex in profile, while the course followed by the anterior limb of the angular line on the cast is a different one.

Although the true systematic position of the genus *Thetironia* cannot yet be said to be established beyond doubt, it is clear that the angular linear marking on the internal casts in no degree coincides with the course of the pallial line. The genus has therefore been erroneously held to be related to members of the Veneridæ, but although its suggested affinity to the Lucinidæ seems to accord better with what is known of its characters,† yet the evidence for such relationship is not of a satisfactory character. Mr. H. Woods, who has examined some material which is very favourably preserved for the purpose of comparative study, has found points of analogy between *Thetironia* and *Protocardia*, both in the characters of the hinge and the ornamentation; but after drawing attention to some features which distinguish these genera, and carefully weighing the available evidence, Mr. Woods concludes that "although *Thetironia* resembles the Cardiidæ in several respects, yet the points of difference are too great to allow of its being included in that family." ‡

Thetironia oblonga sp. nov.

Plate VII., figs. 12, 12*a*, 12*b*.

Description.—The shell is of elongated form, with the length considerably greater than the height. The umbones are situated a short distance anteriorly to the middle of the shell and are fairly well raised and prominent and are strongly incurved. The cardinal margin is very long and is only slightly curved, falling very gently when traced forwards from the umbo and still more gradually posteriorly to the umbones. The greatest height of the shell is at the umbonal part. The height near the posterior end of the shell is greater than in the anterior quarter. In lateral aspect, the cardinal margin is seen to pass by a curve into the posterior margin, which

* Eichwald (1), p. 709, pl. xxvi., fig. 7; Anthula (1), p. 90, Taf. iv., fig. 6.

† See remarks on this point by Miss E. G. Skeat; Skeat and Madsen (1), p. 177.

‡ Woods (3), vol. ii., part 4, p. 167 (1907).

at once falls very steeply with very gently convex outline. This passes in turn by a curve (broader than that of the postero-dorsal outline) into the inferior margin, which has an almost straight outline. The short frontal border has an evenly convex outline. The shell is greatly inflated below the umbonal region, but the valves are compressed in the neighbourhood of the posterior border.

The outer surface of the very thin shell-wall, so far as it has been observed, appears to show only the faintest traces of radial striæ, but delicate radial linear markings are to be seen on the surface of a cast of the interior. The punctate ornaments of the surface may be separated from one another, on the same radial line, by a space of at least 3 mm. in the posterior part of the shell, near the pallial margin. They are less strongly developed and are more closely spaced in the anterior part of the valves.

The well-marked angular linear impression on the posterior side of the umbonal region of the internal cast, has its apex extending almost to the umbonal apex, so that the apical part of the angular line is hidden from view by the incurvation of the contiguous umbones, in a specimen in which the valves are united. The line forms a very acute angle. The posterior limb is relatively weakly impressed, but the anterior limb is well incised and has a very slight backward inclination when traced away from the umbonal apex. In the specimen here described, it only extends for about 5 mm. and then ceases abruptly, while the posterior limb extends for at least 8 mm. and dwindles away.

Dimensions.—

Length	25 mm.
Height, measured from the umbo.........	17 ,,
Greatest depth of a single valve	9 ,,

Occurrence.—Collected at a kloof, S. 5 W. from Comley's house, on the right bank of Sunday's River (83h).

Remarks.—Only one specimen of this form has been found, but it is well characterised by its long cardinal and pallial margins and the relatively small height in comparison with length, as well as by the peculiar form of the angular linear impression on the cast in the umbonal region. The specimen is preserved in the form of an internal cast with portions of the shell adhering, and it is not in the least distorted. So far as I am aware, there is no described species of *Thetironia* with which this new form can be brought into close comparison.

Genus TRAPEZIUM Megerle von Mühlfeldt.

Trapezium? tatei sp. nov.

Plate VII., figs. 13, 13*a*.

Description.—The shell is well elevated in figure, with the umbonal region rising prominently, and well removed from the anterior extremity. The cardinal margin is almost straight posteriorly to the umbo, and slopes back to form a rounded obtuse angle with the straight, very steeply falling posterior border. In front of the umbo the margin falls rapidly, with slightly convex outline, to the sharply convex anterior border. The inferior margin gives a broadly convex outline, and has a sharply angular junction with the posterior border. The greatest height occurs at the umbo, the greatest convexity at about the middle of the valve.

On the posterior side of the valve a sharp carinal ridge passes in steeply inclined direction from just behind the umbonal apex to the postero-inferior angle of the valve-margin. This carina marks off a very well-defined, flattened posterior area, the surface of which is inclined at a sharp angle to that of the remainder of the valve. The valve-surface is devoid of sculpture, but is marked by numerous delicate lines of growth.

Dimensions.—	(1)		(2)
Length	9·5	.	14 mm.
Height	8	.	12 ,,
Depth of a single valve	—	.	4 ,,

Occurrence.—Found on the left side of the Coega Valley, half a mile down from the railway (452g). An imperfect left valve, apparently of the same species, occurring in the same hand-specimen with *Solecurtus sp.* and *Meretrix uitenhagensis* (310), was found at Grass Ridge, three miles east-north-east of Uitenhage.

Remarks.—Unfortunately there is only a single perfect specimen, a left valve, available for description, but this is very well preserved, although the interior characters cannot be studied.

Another shell of still more doubtful generic position, with which this form is comparable in some respects, is *Corbula ? rockiana* Tate.* The general habit is very similar, but a very careful comparison with Tate's type-specimen (number 11023 in the collection of the Geological Society) seems to preclude any idea of uniting these two forms. Tate's species is less elongated, more elevated in figure, and considerably more inflated, particularly in the umbonal region,

* Tate (1), p. 159, pl. viii., fig. 8.

and its carina falls more steeply and forms a line more nearly straight. In *Trapezium ? tatei*, the carina follows a more oblique direction and forms a more curved line when the valve is viewed in lateral aspect. In *Corbula ? rockiana* the umbonal region is broader and more massive, and the incurvation more pronounced. It may be remarked that Tate's figure of *Corbula ? rockiana* is not accurately drawn. The figure gives the idea that there is a depression or concavity on the surface of the valve, whereas this is really not the case in the specimen itself.

A shell of apparently very similar type, so far as external characters go, has been described by G. Müller* from the Lower Cretaceous of German East Africa as *Mactra stromeri.* Another comparable form when large specimens are selected is *Mactra ? angulata* J. de C. Sowerby, from the Blackdown Beds of England.† This, however, is less produced in front and the umbonal region is not so prominently developed and is less incurved. The umbo in *Trapezium ? tatei* is more anteriorly placed and more forwardly directed.

Owing to the scanty material available for study, and the fact that the nature of the interior is at present unknown, the generic position of this shell cannot be satisfactorily settled, although the provisional assignment to *Trapezium* may, perhaps, not prove incorrect. It seems possible, however, that this may be a member of the group, typified by *Cypricardia bathonica* d'Orb.,‡ of the Great Oolite, for which Fischer has proposed the name *Pseudotrapezium*,§ although there can be no certainty on this point.

Genus CYPRINA Lamarck.

Cyprina rugulosa Sharpe.

1856. *Cyprina rugulosa* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 195, pl. xxii., fig. 9.

Occurrence.—This characteristic form was obtained from the green sandy beds, crowded with the remains of oysters, in the cliff below the old school-house at Dunbrodie, Sunday's River (325). Sharpe recorded it from "Sunday River, in greenish shelly grit," and Stow mentions its occurrence above the Modder Drift on the Sunday's

* G. Müller (1), p. 563, pl. xxv., fig. 15.

† J. de C. Sowerby (2), p. 341, pl. xvi., fig. 9.

‡ Morris and Lycett (1), part ii., p. 75, pl. vii., fig. 8 (1853).

§ Fischer (1), fasc. xi., p. 1075 (1887).

River, in association with the characteristic *Trigoniæ* of the Marine Beds. In 1905 Mr. Rogers found this species in the cliff on Buck Kraal, Sunday's River (128h).

Remarks.—*Cyprina rugulosa*, in its inflated character, the position of the umbones, and the wrinkled surface, bears no slight resemblance to *C. regularis* d'Orb.,* from the lower Gault of Europe; it differs chiefly in the manner in which the upper margin slopes away posteriorly into the posterior margin. The European form has greater relative height at its posterior end, with an accompanying aspect of truncation.

Some individuals of *C. rugulosa*, in which the shell attains a rather greater height in proportion to length than in the majority of specimens I have examined, approach somewhat closely in form to a *Cyprina* recorded by Dacqué from strata of supposed Aptian age in Somaliland;† but *C. rugulosa* is less strongly inflated, and most examples are further distinguished by their rough surface markings.

Cyprina borcherdsi Tate.

1867. *Cyprina borcherdsi* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 161, pl. viii., fig. 2.

Occurrence.—Found in the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the line from Uitenhage to Graaff-Reinet, about three miles from Uitenhage (313). The specimens described by Tate were also from the Zwartkop's River.

A specimen obtained by Mr. Rogers from the left side of the Coega Valley, half a mile down from the railway (467g), must also be referred to the same species.

Remarks.—Tate's type-specimen is unfortunately inaccurately figured, and is represented as considerably more elongated than it really is. It measures 42 mm. in greatest length and 31 mm. in height, while the corresponding measurements of the illustration in Tate's paper are 47 mm. and 27 mm. respectively. The greatest depth (convexity) of this type-specimen (a single valve) is about 10 mm. A specimen obtained by Messrs. Rogers and Schwarz is an immature individual measuring 17 mm. in height; it is imperfect anteriorly, and consequently has the aspect of being more equilateral than Tate's shell, though a careful comparison leaves no doubt about its identity.

* d'Orbigny (3), p. 100, pl. 272, figs. 3–6 (1844); Pictet and Campiche (1), 3e Partie, p. 224, pl. cxv., figs. 1, 2 (1865).

† Dacqué (1), p. 16, Taf. ii., fig. 9.

I have been unable to ascertain the nature of the hinge, and must regard the generic determination of this form as provisional. A shell having very similar outward form is *Cyprina swindonensis*, described by the late Prof. Blake* from the Portlandian Swindon Sands of England.

Genus MERETRIX Lamarck (*sensu lato*).

Meretrix uitenhagensis sp. nov.

Plate VII., figs. 14, 14*a*; VIII., figs. 1, 1*a*.

Description.—The shell is of somewhat variable ovate outline, with the umbones situated at about one-third (or slightly less) of the shell's total length from the anterior extremity. The shell-substance is relatively thin and the aspect of the valves considerably compressed and flattened, particularly in the lower half of the individual. The cardinal margin slopes down only very gently when traced back from the umbo, giving a slightly convex outline, and passes by a curve into the posterior border which is evenly convex in outline, or most sharply curved towards the lower part. This border usually has considerably greater extent than the frontal border, which is more sharply curved and limited in height by the somewhat rapid convergence of the upper and lower borders in front of the umbo. The inferior border gives an evenly convex outline. The umbones are little-prominent and gently incurved; they share in the relatively compressed character of the shell. The greatest height of the valve occurs a little posteriorly to the umbo.

The surface is covered with very minute and delicate, concentric, raised linear ornaments, separated by narrow, thread-like striæ; in the lower half of the valve there are about eight of these raised lines within the space of a millimetre. The lines are not all of equal strength, nor are the interspaces equal in breadth, yet they have a much greater aspect of regularity than that shown by mere striæ and ridges of growth. Behind the umbones, the flank of each valve passes over into the well-sunk ligament space without carination, but forming a rounded, blunt, pillow-like margin which, when observed in profile, conceals the ligament. The ligament (preserved in some specimens) in an individual measuring 14 mm. in length, extends back from the umbones for a distance of 5 mm.

* Blake (1), p. 232, pl. x., fig. 2.

Dimensions.—	(1)		(2)		(3)		(4)
Length	14	.	16	.	17	.	20 mm.
Height, measured at the middle of the valve	11	.	12	.	13	.	16 ,,
Greatest depth of a single valve	3	.	3·5	.	3·5	.	4 ,,

Occurrence.—Found in the kloof east-north-east of Red House, on the left side of the Zwartkop's River (324), and at Grass Ridge, three miles east-north-east of Uitenhage (310); also in the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the line from Uitenhage to Graaff-Reinet, about three miles from Uitenhage (316). A specimen sent from the South African Museum is from the Sunday's River, occurring with *Holcostephanus* cf. *atherstoni* (Sharpe). Mr. Rogers obtained specimens of this form, in 1905, from the left side of Coega Valley, half a mile down from the railway (453g, 454g); from a bare slope, W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop, Sunday's River (24h, 26h, 28h–30h); and from the highest beds in the kloof behind Colchester, left bank of Sunday's River (493g, 498g).

Remarks.—Although this elegant shell shows some variation in outline and in the degree of inflation, yet the individuals here brought together agree on the whole very closely and are well characterised. The chief features of the shell are the generally rounded and soft outline, the inconspicuous, rounded umbonal region, and the very compressed form of the valves.

In outline, the shell resembles some specimens of *Venus orbignyana* Forbes,* from the Lower Greensand of the Isle of Wight, which differs, however, by the considerably stronger inflation and the more marked anterior excavation under the umbones. *Meretrix uitenhagensis* has a less steeply sloping upper margin posteriorly to the umbones, and the umbones are less prominent. The minute concentric linear striæ are developed also in *Venus orbignyana*, though more faintly marked than in the African shell.

Meretrix parva (Sow.),† also from the Lower Greensand of England, is more circular in outline, more nearly equilateral, and considerably more inflated in form.

Meretrix brongniarti (Leymerie)‡ is a larger and more massive shell, and even if compared at the same dimensions is seen to be more elongated and posteriorly attenuated in outline, and more equilateral.

* Forbes (1), p. 240, pl. ii., fig. 5.

† J. de C. Sowerby (1), vol. vi., Tab. 518, figs. 4–6 (1826).

‡ Leymerie (2), p. 5, pl. v., fig. 7; pl. vii., fig. 1.

Meretrix labadyei (d'Archiac),* from the Tourtia of Tournay, has an almost identical outline, but its valves are much more convex. The same character distinguishes several other Cretaceous forms ascribed to *Cytherea* or *Venus*, which, when compared with our shell, are seen to have a very similar outline.

In the shape of the shell, the inconspicuous umbones, and the compressed form, resemblance is shown to *Tapes picteti* de Loriol,† from the Gault of Cosne (Nièvre), which, however, is not so elongated relatively to height, and moreover, has a coarser concentric ornamentation. A similar resemblance is shown to *Tapes patagonica* Stanton,‡ from the Belgrano beds (Lower Cretaceous) of Patagonia, but the points of distinction are plainly seen in the less elongated figure, the greater inflation, and the coarser concentric ornamentation of the Patagonian shell.

A shell from supposed Lower Cretaceous strata in the Cameroons (left bank of Mungo River), described by von Koenen § as *Cytherea wohltmanni*, differs from *Meretrix uitenhagensis* in the greater inflation, the more inequilateral form, and the prominence of the umbonal region.

A word may be added regarding the generic position of this form. In no specimen has the interior been seen, so that a precise generic determination cannot really be made with certainty; but a comparison with other species in which the hinge-teeth are known, justifies a provisional reference to *Meretrix*, if this name be applied in the broad sense in which the name *Cytherea* has for long been used, with reference to Cretaceous forms. The tendency of modern work is to set closer and closer limits to the application of long-established generic names amongst lamellibranchs, as in other classes of Mollusca. It is highly probable, when evidence of internal characters can be obtained, that an extension of this principle to Cretaceous forms, on the lines carried out in the classification of recent and Tertiary species, may eventually show the inapplicability of the name *Meretrix* (equivalent to *Cytherea* as commonly used) to such a form as the one here described. From practical considerations, however, it will often be necessary, as in the present case, to continue to utilise in a broad sense a name which, though perhaps technically wrong, conveys as definite a meaning as the available evidence for the time being allows.

* d'Archiac (1), p. 303, pl. xiv., fig. 7. † de Loriol (4), p. 64, pl. vii., fig. 21.

‡ Stanton (3), p. 23, pl. iv., figs. 12, 13.

§ von Koenen (1), p. 36, Taf. iv., figs. 6, 8, 9; since shown to be of Upper Cretaceous age, see Solger (1).

Genus PSAMMOBIA Lamarck.

Psammobia atherstoni Sharpe.

1856. *Psammobia atherstoni* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 196, pl. xxii., fig. 11.

This was found in the cliff below the old school-house at Dunbrodie, on the right bank of Sunday's River (321, 325). A specimen from this locality, submitted to me, agrees very closely with the largest individual figured by Sharpe. The Dunbrodie specimen measures 25 mm. in length and 15 mm. in height; it is a left valve, having the characteristic compressed form and flattened flank and very inconspicuous umbo. Sharpe records this shell from the "Sunday River near Enon, in a grit sometimes full of the casts of the shell." At Dunbrodie *Psammobia atherstoni* is associated with *Actæonina atherstoni*, *Turbo atherstoni*, *Pecten cottaldinus*, and other forms. Messrs. Rogers and Schwarz mentioned the occurrence of *Psammobia atherstoni* in the Wood Bed series of the Bezuidenhout's River below Blue Cliff,* but this name was probably applied to specimens which I have referred to the genus *Unio*.

The generic determination of this species must be regarded as provisional. No specimens showing satisfactorily the internal characters have been available for study, and true relationship with *Psammobia* (or *Gari* Schumacher, if this be regarded to have synonymic value) still remains to be proved. The propriety of considering the name *Gari* to possess the same significance as that which has been ascribed to *Psammobia* (sensu lato) is perhaps still open to question. The shells we are dealing with in the present instance are smooth and without radial markings, and this fact, together with the slight doubt concerning even the broader generic relationships, seems to justify the retention, for the time being, of Lamarck's more familiar and more widely accepted name. It appears reasonable, under the circumstances, to use as a provisional measure a nomenclature which clearly indicates the supposed relationships, though it may perhaps be technically erroneous. To hazard a "correction" of nomenclature on an insecure basis of imperfect knowledge is a step for which it would probably be more difficult to find justification.

* Rogers and Schwarz (1), p. 13.

Genus SOLECURTUS H. D. de Blainville.

Solecurtus sp.

Text-figure 1.

Description of a Single Specimen.—The specimen is a right valve, slightly imperfect at the siphonal margin. The umbo is very inconspicuous, and is situated slightly in front of the middle of the shell. The upper margin slopes down very gently in front and behind the umbo. The frontal margin is short and has a rounded convex profile ; towards this margin the upper and lower valve-borders very gently converge. Towards the siphonal margin the valve has a slightly greater height than in the anterior half. The surface is marked by lines of accretion, but no trace of ornamentation has been observed. The inflation of the valve is very slight.

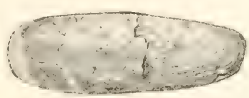

Fig. 1.—*Solecurtus sp.*, nat. size. Survey Collection.

Dimensions.—

Length (if restored).....................	31 mm.
Height at the umbo.....................	12 ,,
Depth of the valve, about	3 ,,
Length of siphonal margin............	9 ,,
Length of frontal margin	6 ,,

Occurrence.—Found at Grass Ridge, 3 miles east-north-east of Uitenhage (310).

Remarks.—The single specimen examined is not quite complete at the posterior end, and, unfortunately, the surface is so preserved as to leave no traces of faint linear sculpture, if such markings were ever present. By following the growth-lines it is possible to arrive at the original form of the posterior border. In shape the shell agrees very closely with *Solecurtus warburtoni* Forbes,* from the Aptian of Atherfield (Isle of Wight) ; the umbo occupies a similar position, and the valve is anteriorly rounded, with diminished height towards the frontal border, while posteriorly the height is greater. The only clearly observable difference is that, in specimens of similar dimensions, the measurement from the umbo vertically to the inferior margin is relatively rather smaller in the English shell.

* Forbes (1), p. 237, pl. ii., fig. 1.

This also has very faint and delicate radial, linear ornamentation on the anterior part of the flank, but the African shell may originally have borne similar minute sculpture, and on this point nothing further can at present be said.

Similar forms were described by d'Orbigny, under the name *Solen*, from the Lower Cretaceous (*S. robinaldinus*) * and from the Chalk (*S. æqualis*).† Guéranger has figured a shell from the Cenomanian of the Sarthe under the name *Solecurtus æqualis*,‡ to which our specimen appears to bear a close resemblance, so far as comparison is possible.

Genus MACTRA Linn.

Mactra ? dubia sp. nov.

Plate VIII., figs. 2, 2*a*, 3, 3*a*.

Description.—The shell has greater length than height, and the umbones are situated at rather more than one-third of the shell's total length from the anterior extremity. The inflation is moderate, and most strong just above the middle of the valves. The umbones are somewhat weakly developed and are not very prominent. The cardinal margin and the posterior margin form together a curved outline which passes down, posteriorly very steeply, to a marked angular junction with the lower border. From the umbo a well-marked carina passes obliquely across the posterior part of the valve, down to the postero-inferior angle of the valve-margin. The carina marks off a flattened or very slightly concave postero-superior area which occupies less than one-quarter of the total valve-surface. In front of the umbo the valve-margin slopes down to form a somewhat sharply curved outline in front, the foremost point of the anterior margin falling well within the lower half of the shell. The long pallial margin shows a broadly convex outline, sometimes slightly flattened towards the posterior end. The greatest height of the valve occurs at the umbonal part. The surface is smooth, with numerous delicate growth-lines, and shows closely spaced radial rows of very minute punctæ, only visible under a lens.

Dimensions.—

	(1)		(2)
Length	15	.	15 mm.
Height, measured from the umbo	12	.	12 ,,
Greatest depth of a single valve	4	.	3·5 ,,

* d'Orbigny (3), p. 320, pl. 350, figs. 1, 2 (1845).

† d'Orbigny (3), p. 321, pl. 350, figs. 5–7 (1845).

‡ Guéranger (1), pl. xv., fig. 3.

Occurrence.—Found in the cliff on Buck Kraal, Sunday's River (141h).

Remarks.—The doubtful reference of this form to *Mactra* is, it must be admitted, unsatisfactory. The generic position, in fact, is very uncertain, for the characters of the hinge are unknown and the ligament space is relatively extensive. The general aspect of the shell does not accord well with either *Cyprina* or *Meretrix.* The specimens share with *Mactra angulata* J. de C. Sow. (Blackdown Beds),* the sub-angular junction of the posterior and inferior margins and the presence of a defined ridge running obliquely from the umbo down to the base of the posterior margin. In *M. angulata,* however, the shell is more triangular and less ovate in outline, and the umbonal region is more prominent and tumid, less anteriorly placed, and less strongly directed forwards.

Mactra warrenana Meek and Hayden (Cretaceous of Dakota) † is in some degree comparable, but differs by its more trigonal form, more prominent umbonal region, and the presence of a defined lunule of relatively large size.

Genus PLEUROMYA L. Agassiz.

Pleuromya baini (Sharpe).

Plate VIII., figs. 4, 4*a*.

1856. *Myacites ? bainii* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 195, pl. xxii., fig. 7.

Occurrence.—The locality given by Sharpe was merely "Sunday River." Specimens were collected by Messrs. Rogers and Schwarz at Grass Ridge, 3 miles east-north-east of Uitenhage (317, 318, 334, 335), from an outcrop of nodular limestone, the highest fossiliferous outcrop of this locality, where many characteristic fossils of the Sunday's River Beds were found.‡ *P. baini* was also found to occur commonly in the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the line from Uitenhage to Graaff-Reinet. Mr. Rogers obtained a very well-preserved specimen from the highest beds in the kloof behind Colchester, Sunday's River Valley (495g).

Remarks.—There is some variation in the form of the shell, and the inferior margin, though never showing a strongly curved outline, is not always so straight as depicted in Sharpe's figure. When well

* J. de C. Sowerby (2), p. 341, pl. xvi., fig. 9.

† Meek (2), p. 208, pl. xxx., fig. 7.

‡ Rogers and Schwarz (1), p. 9.

preserved the surface is seen to be covered with closely spaced radial lines of delicate granules.

Although possessing no highly distinctive external features, this shell retains a certain characteristic aspect, while approaching somewhat closely to some European representatives of the genus. It may usually be easily distinguished from the larger *Pleuromya lutraria* (Krauss),* another characteristic shell of the Sunday's River Beds, with which it is associated. If mature specimens be compared, *P. lutraria* is distinguished by its much larger dimensions. If small specimens of this be brought into comparison with mature examples of *P. baini* of equal size, there is a considerable general similarity between them; but *P. lutraria*, when young, has a definite ornamentation of rounded concentric ribs, whereas *P. baini* is a smooth shell, with the surface only marked by lines of growth and minute granules. The umbones of *P. lutraria* are rather more prominent, and are perhaps situated a little nearer to the anterior extremity, while the margin in front of the umbo slopes down more suddenly than in *P. baini*.

Pleuromya neocomiensis (d'Orb.) † is a similarly elongated form, but is distinguished by marked anterior truncation. *P. rostrata* (d'Orb.) ‡ is more produced posteriorly and has a more curved inferior outline. Some individuals of *P. baini* closely resemble a *Pleuromya* from the Lower Greensand of the Isle of Wight which has been considered, apparently erroneously, to represent d'Orbigny's *P. neocomiensis*, and is much more likely to be identical with *P. schröderi* (Wollemann),§ from the Neocomian of North Germany. To judge from Dr. Wollemann's description and figure, *P. schröderi* approaches very closely indeed to *P. baini*.

Another shell which shows considerable resemblance to *P. baini* occurs in the Neocomian sandstone of the Teutoburger Wald, and was ascribed by Weerth,‖ though perhaps erroneously, to d'Orbigny's *Panopæa neocomiensis*; the general similarity is great, but the shell figured by Weerth has an inferior margin presenting a rather more curved outline.

The shell from the Neocomian of North Germany, described by F. A. Roemer ¶ as *Pleuromya solenoides*, is an elongated form with

* Krauss (2), p. 447, Tab. xlvii., fig. 1.

† d'Orbigny (3), p. 329, pl. 353, figs. 3–8 (1845).

‡ d'Orbigny (3), p. 333, pl. 355, figs. 3, 4 (1845).

§ Wollemann (1), p. 126, Taf. v., fig. 7 (as *Panopæa*).

‖ Weerth (1), p. 37, Taf. viii., fig. 7.

¶ F. A. Roemer (3), p. 330, pl. xli., figs. 20 21.

straight upper margin and little-curved lower margin. *P. baini* differs from this in being more equilateral and less produced and truncated posteriorly.

As regards the generic position of this shell, although the hinge-characters have not been described and I have been unable to investigate them, there is no reason to doubt that we are dealing with a typical *Pleuromya*, to which genus belong also, in all probability, the majority of the Neocomian forms to which the name *Panopæa* was formerly applied. There is no reason to suppose that the hinge-characters of *P. baini* differ essentially from those of *P. lutraria*, with which it is associated; and although it was the nature of the hinge that led Krauss to propose for the latter form the separate generic name *Anoplomya*, it appears plain from Terquem's * detailed studies of the genus *Pleuromya* that the name proposed by Krauss must be regarded as a synonym—a view already adopted by Zittel.†

Genus GONIOMYA J. L. R. Agassiz.

Goniomya sp.

This genus is represented by a single specimen of a small right valve. It is unfortunately imperfect, with a large part of the shell substance removed, and it is embedded in a very hard matrix which cannot be removed without further injury to the delicate shell.

Description.—The valve has little convexity and is posteriorly well produced. The umbo is rather pointed and prominent and shows a weak fold of the valve-surface extending for a short distance on its posterior side. The shell-substance is very thin and delicate. The ribbed ornaments of the surface are developed already close to the umbonal apex, where the anterior and posterior ribs are very delicate and closely spaced and are steeply inclined to form the V-pattern. The angle of the V is very acute, and the successive angles formed by the junction of the ribs of the two series are situated at first just below the umbonal apex, and then below one another on the flank on a slightly oblique line posteriorly inclined, so that the lowest angles of the sculpture are situated more backwardly than those above. The most backwardly situated ribs, which do not contribute to the angular ornamentation, are posteriorly inclined when traced down from their upper terminations. Posteriorly to the umbo there is a broad smooth area devoid of sculpture on the upper part of the valve, but this is not sharply demarcated from the flank.

* Terquem (1); Terquem (2). † Zittel (5), p. 125.

The anterior ribs are narrower and perhaps rather more prominent than the posterior ribs. Delicate and fairly regular lines of growth cross the surface of ribs and interspaces alike. The surface of the shell, where well preserved, is seen to be covered by very numerous and delicate, radially disposed lines of minute granules.

Dimensions.—The anterior part of the specimen is hidden in the matrix, but to judge from the course taken by the anterior growth-lines, the length of the valve may be fairly accurately estimated as 22 mm. The umbo is situated at about one-third of the total length from the anterior extremity, assuming that the above length-measurement is correct. The height of the valve at the umbonal region is 13 mm. The height of the siphonal border is 8 mm.

Occurrence.—Collected by Mr. Rogers from the highest beds in the kloof behind Colchester, Sunday's River Valley (489g).

Remarks.—This is the first specimen of *Goniomya* recorded from the Uitenhage Series. The condition of the single valve available for comparison scarcely justifies a specific determination, and the question of relationships cannot be usefully discussed without better material for study but the specimen probably represents a new species.

It is interesting to find the genus *Goniomya* represented here, in strata which yield the peculiar *Trigoniæ* of the group of *T. vau* which so strongly simulate the genus *Goniomya* both in the arrangement of the costate ornaments and in the general habit. Though the specimen above described at once recalls these *Trigoniæ*, it may be readily distinguished from them by the very thin shell-wall and the presence of surface granulation, as well as by the details of ornamentation. In *Trigonia vau* Sharpe and its allies, the neanic stage is ornamented by concentric ribs passing across the flank and area, and the inclination of the ribs with resulting angular pattern is not produced until the early adult stage. In this *Goniomya*, the costæ formed an anterior and a posterior series, steeply inclined, already in the neanic stage, at a very much shorter distance from the umbonal apex than in the *Trigoniæ* mentioned.

Genus THRACIA W. E. Leach.

Thracia sp.

Plate VIII., fig. 5.

A single specimen, which must be ascribed to this genus, is scarcely so well preserved or so strongly characterised as to allow

of a thorough comparison with known forms, or to warrant the use of a new specific name. The posterior end is slightly broken away so that the exact outline of the shell here cannot be clearly seen. The length is considerably greater than the height; the valves are of a compressed form, most convex in the uppermost third, more flattened below. The umbones are little conspicuous and are directed very slightly backwardly; they are situated just posteriorly to the middle of the shell. The upper margin slopes down very gently in front of the umbo, with an almost straight profile which passes into the evenly convex outline of the frontal margin. The posterior compressed area is well defined, especially in the neighbourhood of the umbo.

Dimensions.—

Length	40 mm.
Height, measured from the umbo.........	29 ,,
Depth of one valve	8 ,,

Occurrence.—In the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the line between Uitenhage and Graaff-Reinet, about three miles from Uitenhage (331).

Remarks.—Comparison with English specimens of *Thracia phillipsi* Roem.,* from the Speeton Clay, shows that these differ widely from the shell before us by their much more inflated and prominent umbonal region and more steeply sloping antero-superior margin. In general form and outline the African shell shows close similarity to *Thracia subtruncata* Meek, from the Cretaceous strata of Sucia Islands (British Columbia).† The outline also somewhat nearly resembles that of *Thracia gracilis* Meek and Hayden,‡ from Cretaceous sandstone at the mouth of the Judith River (on the Missouri), but the latter is rather more elongated posteriorly.

Another shell which may be brought into close comparison occurs in the Aptian of Spain (Obon and Utrillas) and was described by Coquand § as *Periploma lorieri*. To judge by Coquand's figure, this differs from the Uitenhage form by the steeper inclination of the carinal ridge and the more nearly parallel direction of the upper and lower margins anteriorly to the umbo.

* *Mya depressa* Phillips, (1), Tab. 2, fig. 8 (*non* Sow.); *Thracia phillipsi* F. A. Roemer, (2), p. 74, Taf. 10, fig. 1 (1841).

† Whiteaves (2), p. 140, pl. 17, fig. 7.

‡ Meek (2), p. 224, pl. 39, fig. 6.

§ Coquand (1), p. 100, pl. ix., figs. 5, 6.

Thracia robinaldina (d'Orbigny)* is distinguished by its more oblong and less ovate outline, and its more conspicuous umbones. The African shell compares again more closely with the figure of a specimen from the Lower Cretaceous (Rolling Downs Formation) of Queensland, ascribed by Etheridge with some doubt to *Thracia primula* Hudleston, and figured under the generic name *Corimya*.† Less similarity is shown to the specimen originally named *Thracia primula*,‡ preserved in the British Museum (Natural History); this has greater relative height anteriorly to the umbo, a more curved inferior margin, more strongly compressed valves, a less inflated umbonal region, and less definitely developed posterior carination.

Genus GASTROCHÆNA L. Spengler.

Gastrochæna dominicalis Sharpe.

1856. *Gastrochæna dominicalis* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 198, pl. xxiii., fig. 4.

Sharpe described under this name a shell which had bored into a fragment of wood,§ found on the Sunday's River "near Enon." He also mentions the occurrence of *Gastrochæna* boring into fragments of wood and *Trigonia*-shell, also from the Sunday's River.

Fragments of fossil wood bored by *Gastrochæna* were collected by Messrs. Rogers and Schwarz from an oyster bed at the base of the cliff below the old school-house at Dunbrodie, Sunday's River (336). The shells are concealed within the short calcareous tubes which line their cavities, and some of these crypts measure about 6 mm. in length. There is no reason to doubt that these specimens represent the same form as that described by Sharpe. This shell was also found boring into lignite in strata of the "Wood Bed" series of the Bezuidenhout's River below Blue Cliff station.

* d'Orbigny (3), p. 380, pl. 372, figs. 1, 2 (1845).

† Jack and Etheridge (1), p. 481, pl. 28, fig. 11.

‡ Hudleston (1), p. 245, pl. ix., fig. 7.

§ Sharpe spoke of this fragment as "bone," but this was corrected on p. 228 of Sharpe's paper and by Prof. T. Rupert Jones in an editorial footnote to Tate's paper in 1867, Tate (1), p. 155.

Class GASTEROPODA.

Genus PATELLA Linnæus.

Patella caperata Tate.

1867. *Patella caperata* R. Tate, Quart. Journ. Geol. Soc., vol. xxiii., p. 152, pl. vii., fig. 1.

Occurrence.—A single specimen, on *Exogyra imbricata* Krauss, from the collection of the South African Museum, was obtained at Coega. Tate's figured specimen, in the collection of the Geological Society (No. 11,003), is labelled "Prince Alfred's Rest" (Sunday's River).

Remarks.—The specimen from Coega is more strongly elevated in form than Tate's original type. The apex in both is excentric in position, and as a result of this, the outline from the apex to the margin on the shorter side of the shell falls more steeply than that on the opposite side. Annular markings and growth-lines are more marked on Tate's specimen, because its surface has suffered less from weathering than that of the other individual.

The figured type of this species measures 28 mm. in longest diameter at the base, and the measurement at right angles to this, across the shortest diameter, is 22 mm. The height is 10 mm. The true dimensions of the Coega specimen cannot be measured satisfactorily because the shell has so suffered from weathering that its original margins are not preserved. There are indications that a firmly established station had been taken up, on the *Exogyra.* In one place, on the surface of the *Exogyra,* in the position which the serrated margin of the *Patella* formerly occupied, there are indentations which correspond with the terminations of the costæ on the *Patella.*

Genus PLEUROTOMARIA J. L. M. Defrance.

Pleurotomaria sp.

Description.—A large, ill-preserved and much-weathered specimen consists of at least five whorls. The body-whorl is flattened on its under side and its outer margin is obtusely angular; the surface of the whorl above this margin is very slightly convex. The suture falls at the bluntly angular margin of the whorls, so that the general figure of the shell in profile is that of a cone with little excavation at the sutural depressions and inconspicuous convexity of the outline

between these. The mouth aperture is of transversely oval form. The surface is so far weathered that no sculpture can be seen except on the base, where traces of numerous raised longitudinal (spiral) ornamenting ridges, crossed by ridges of growth, may be detected. The spiral angle is about 85°.

Dimensions.—

Height	90 mm.
Greatest width of base	100 ,,
Height of aperture	44 ,,
Approximate breadth of aperture	55 ,,

Occurrence.—Collected by Miss Wilman at Coega.

Remarks.—This single specimen is the first representative of its genus yielded by the Uitenhage beds, and it is a matter for regret that the preservation is so indifferent that a more precise description of characters is impossible. We must await the addition of further material before the nature of the sculpture can be ascertained and the nearer relationships made clearer; in the meantime it would be unjustifiable to propose a specific name. In general figure the shell is not unlike *Pleurotomaria* (*Leptomaria*) *tithonia* Zittel,* but the spiral angle is rather wider than in that form, and if viewed in aperture-aspect it is seen that the whorl is deeper in section in the Uitenhage shell, and the mouth much less transversely elongated.

The form of the whorls is not unlike that of *Pleurotomaria tardensis* Stanton,† from the Belgrano beds (Lower Cretaceous) of Patagonia, which is also similar by reason of its large dimensions; but in the Coega specimen the outer margin of the body-whorl is less broadly rounded and the spiral angle is rather smaller.

Genus TURBO Linnæus.

Turbo atherstoni Sharpe.

Plate VIII., figs. 6, 6*a*, 7, 7*a*, 7*b*.

1856. *Turbo atherstoni* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 200, pl. xxviii., figs. 15, 16.

1856. *Turbo baini* D. Sharpe, *Ibid.*, p. 200, pl. xxviii., figs. 17, 18.

Supplementary Descriptive Note.—The shell consists of about six whorls, the first four of which have a smooth, flat, or very slightly concave upper surface, sloping down very gently from the spiral suture. The outer side of the whorl is truncated, with a sharp and

* Zittel (4), p. 337, Taf. 50, figs. 5, 6.

† Stanton (3), p. 29, pl. vii., figs. 1, 2.

prominently projecting longitudinal (spiral) keel limiting the truncated band above, and also a similar one below. Under the lower marginal keel the surface of the whorl is gently convex in profile and slopes rapidly in. Just below the lower marginal keel there is a narrow, deep spiral sulcus bounded below by a delicate thread-like longitudinal keel. Below this there are four weaker raised spiral lines which are already developed in the third whorl, if not before. Until the fourth whorl is reached, the slightly concave outer band between the prominent marginal keels is smooth, but before this whorl is completed, in some individuals at its commencement, a weaker central keel appears.

The spiral angle varies somewhat, and averages about 70°. The last two whorls expand rapidly. The spiral suture is situated on the lower marginal keel of the whorls. The mouth has an angular outer lip, corresponding with the form of the whorls. The outer margin of the aperture is thin and sharp; under the columella the margin is slightly thickened.

Dimensions.—

Height of a specimen with four complete whorls	5 mm.
Diameter of the fourth whorl........................	4 ,,
Height of a specimen with five (or six ?) whorls	14 ,,
Diameter of the body-whorl...........................	9 ,,

Occurrence.—Found in the cliff below the old school-house at Dunbrodie on the Sunday's River (351), where it is abundant. Specimens in the collection of the Geological Society of London are from "the lowest strata of the Zwartkop crag," and "greenish grit with *Ostreæ* from Sunday River," as recorded by Sharpe. This form was obtained by Mr. Rogers in 1905 in a cliff W. 20 S. from Comley's house, right bank of Sunday's River (95h).

Remarks.—It is clear from a careful examination of the specimens in the collection of the Geological Society, together with the new materials supplied to me, that Sharpe was in error when he separated the shells described by him as *Turbo atherstoni* and *T. baini*. The differences which caused him to make the separation are in reality due to changes in the nature of the ornamentation during successive stages of growth; but the specimens at his disposal were very small and the materials so comparatively unsatisfactory that the mistake is not surprising. All specimens having the two marginal keels only, and consequently agreeing with the type of *T. atherstoni*, are very small individuals which have not reached the stage in which, by the intercalation of a central marginal keel and the more prominent development of the spiral ornaments on the lower part of the whorl,

the features of *T. baini* are exhibited. The change in characters is found to be very constant, although some slight variation may be shown as regards the exact period, in relation to the precise number of whorls developed, when the additional keel makes its appearance. In this connection also, differences of preservation prove very deceptive. As the adult stage becomes completed, it is noticeable how relatively rapidly, by the greater expansion of the whorls, the shell gains in length when compared with the proportional dimensions of the young individual.

This well-characterised form seems to resemble very closely *Turbo reedi* W. Keeping,* from the Lower Cretaceous of England, and may be more aptly compared with this than with any other European shell with which I am acquainted. The type of ornamentation is essentially similar as regards major features, and while Keeping gave no account of the variation of sculptural characters when traced through successive stages, it seems probable that the central marginal keel became added between the two prominent keels during the course of individual growth, just as in *T. atherstoni.* The principal points by which the English shell differs, are seen in the greater number of spiral ribs on the lower part of the body-whorl and in the very delicate spiral striation and resulting granulation of the surface.

A somewhat analogous type of ornamentation is exhibited by a shell from the Upper Neocomian of Utrillas (Teruel), described as a *Trochus*, under the name *T. maestrei*, by de Verneuil and Lorière.† This, however, shows only two marginal spiral keels, while the base of the body-whorl is ornamented by several strong, well-spaced keels. Further points of distinction are the fine spiral lines which ornament the whorls, and the wider spiral angle.

A form which perhaps merits mention by way of comparison occurs in the Upper Jurassic *Aucella*-beds of Novaya Zemlya, and was ascribed by Tullberg to Münster's *Turbo capitaneus.*‡ This has ornaments similar to those of *T. atherstoni*, but there is less overlap of the whorls, the upper and lower marginal keels are less prominent and of similar strength to the central one, and the outline of the whorl is more rounded and less angular. There are apparently other differences, so far as it is possible to make comparison with the figure of the relatively large specimen figured by Tullberg.

* Keeping (1), p. 97, pl. iii., fig. 13.
† de Verneuil and Lorière (1), p. 23, pl. ii., fig. 9.
‡ Tullberg (1), p. 9, pl. ii., fig. 1.

There is much closer resemblance, again, to *Turbo bitropistus* Ascher, from the Grodischter Schichten (of Hauterivian age) in Silesia.* This, however, has a relatively narrower band between the two sharp marginal keels, and moreover, the surface of the shell is ornamented with numerous and delicate spiral lines.

TURBO ROGERSI sp. nov.

Plate VIII., figs. 8, 8*a*, 8*b*.

Description.—The shell consists of six whorls, possibly more. The whorls are flattened above, and the upper surface slopes very gently away from the spiral suture, terminating abruptly at a prominent marginal keel which marks the upper limit of the outer truncated face of the whorl. This truncated portion is straight in profile in the earlier whorls, but becomes gently but distinctly convex in the fourth or fifth whorls; it is bounded below by a prominent marginal spiral keel similar to the one above. Already in the third whorl, a central spiral keel makes its appearance, and this soon grows in strength, so that in the fourth whorl it is almost, if not quite, as prominent as the two pre-existing marginal keels, and subsequently it remains quite as conspicuous as these. At the completion of the fourth whorl, or perhaps a little before this, two additional well-marked, thread-like, raised linear ornaments become intercalated, one above and one below the central marginal keel. The lower part of the body-whorl shows a rounded, convex surface ornamented by about five delicate spiral keels, of which the uppermost is the strongest and is separated by a narrow sulcus from the lowest marginal keel.

The spiral angle is about 75°. The overlap of the whorls is such that the suture coincides with the lowest keel of the marginal area. In the earlier whorls the outwardly truncated form of the whorls gives a step-like profile with vertical outer face; in the later growth-stages (about the fifth whorl) the upper surface of the whorls becomes a little more convex and less abruptly demarcated from the marginal face, while the latter becomes more convex and merges gradually into the lower part of the whorl, so that the marginal truncation becomes successively obscure and lost and the whorl attains an aspect of even convexity. The mouth is then almost circular in outline, with thin outer lip not showing angularity of form. In the fifth whorl an indistinct and weakly developed sulcation appears on the upper surface of the whorl, immediately above the upper marginal keel and running parallel to it.

* Ascher (1), p. 139 [5], pl. xii. [i.], figs. 1*a*–1*c*.

Dimensions.—

Height of specimen with five whorls ... 11 mm.
Diameter of the fifth whorl .... 7 ,,

Occurrence.—In the cliff below the old school-house at Dunbrodie, on the right bank of Sunday's River (282).

Remarks.—This shell, represented in the collection by only two specimens, appears to be so closely related to *Turbo atherstoni* that at first I felt some hesitation in definitely separating it. A careful comparison with the specimens of *T. atherstoni* from Dunbrodie and those in the museum of the Geological Society shows, however, that it possesses distinctive characters which appear in no specimen of *T. atherstoni* that I have examined; the points of difference are as follows. In *T. atherstoni* the upper and lower marginal keels are very prominent and the outer area of the whorl concave in profile; the marginal keels in *T. rogersi* are less pronounced and the outer truncated area flat and vertical in profile in the earlier whorls. The central keel of *T. rogersi* makes its appearance much earlier and gains in strength so that it rapidly becomes as prominent as the two original peripheral keels; this equality is not attained in *T. atherstoni.* In *T. rogersi* two additional raised ornamenting lines appear on the peripheral area, while larger specimens of *T. atherstoni*, illustrating a more advanced stage of growth, have shown no similar development. Another feature of distinction is seen in the manner in which the whorls of *T. rogersi* lose their angularity of form with advancing growth and present an even convexity of surface not seen in the largest specimens of *T. atherstoni.* It is impossible to speak with certainty of any differences in the spiral angle, but the comparison of additional specimens, when these are forthcoming, may possibly show that the angle of *T. rogersi* rather exceeds that of *T. atherstoni.*

A *Turbo* described by Zittel from the Stramberg beds under the name *Turbo eryx* d'Orb., var. *major** is of similar type to *T. rogersi*, but differs in the more expanded form and wider spiral angle, and in the details of the spiral linear ornaments.

Turbo minutulus sp. nov.

Plate VIII., figs. 9, 9*a*, 9*b*.

Description.—The shell consists of at least four whorls, and these are flattened above and sloping gently away from the suture, but vertically truncated at the periphery. The truncated marginal band

* Zittel (4), p. 321, pl. xlviii., fig. 10.

is bounded above and below by a prominent longitudinal (spiral) keel; these two principal keels are of equal strength, and while the lower one is smooth (or nearly so), the upper one is bluntly nodular. Each of the rounded nodes of this keel is prolonged in wedge shape downwards into the marginal band, but the apices of the wedges die out before they reach the lower keel. At the end of the fourth whorl the wedge-like ornaments appear to be losing the well-defined character they possessed at the beginning of this whorl and before, while early in the fourth whorl an intermediate (central) peripheral keel makes its appearance, though it is less strongly developed than the two pre-existing marginal keels.

Below the marginal band the surface of the body-whorl has an evenly rounded outline; it is ornamented by three prominent spiral keels, one situated near the lower marginal keel and almost as strongly developed as this, the other two, rather weaker, below and in close proximity to one another. The spiral angle is about 70°. The spiral suture is immediately under the lower marginal keel. The mouth aperture has equal breadth and height. The outer lip is sharp and thin and slightly angular, in accordance with the form of the whorl. The inner lip is slightly thickened.

Dimensions.—

Height of specimen with four complete whorls	8 mm.
Greatest diameter of the last whorl...............	6 ,,
Height of aperture....................................	4 ,,

Occurrence.—Cliff below the old school-house at Dunbrodie, on the right bank of Sunday's River (305, 351).

Remarks.—This form, though apparently a near ally of *Turbo atherstoni* and *T. rogersi*, is readily separable from these by the regular nodose ornaments on the upper marginal keel and peripheral zone below this, as well as by the stronger development and smaller number of the spiral keels on the under surface of the whorl, below the lower marginal keel. It seems probable that this shell would attain dimensions as large as those reached by *T. atherstoni*, and the appearance of a central marginal keel in the last whorl of the largest individual examined very strongly recalls the increase of the spiral ornaments in the associated forms mentioned.

Turbo sp.

An imperfect specimen, consisting of a body-whorl deprived of the spire, may be provisionally referred to this genus. The greatest breadth across the base is 8 mm., and the diameter of the mouth aperture which is nearly circular, measures 4 mm. The surface is

ornamented by rounded, shallow spiral grooves, and blunt spiral ridges having little prominence. These ornaments are so disposed that above the peripheral area a weakly marked ridge forms the outer limit of a narrow shoulder which is without spiral sculpture, while on the lower part of the peripheral area is a spiral groove, slightly broader than the three remaining grooves which lie below it. The surface is crossed transversely by numerous and well-marked ridges and furrows of growth, which are so regularly developed as almost to appear to constitute part of the sculpture.

Occurrence.—This was found, in association with the three forms previously described, in the cliff below the old school-house at Dunbrodie, Sunday's River (351).

Remarks.—This imperfectly preserved specimen is quite distinct from the other forms assigned to the genus *Turbo*, described above, but it will be well to await the collection of further material before applying a specific name. It can hardly even be said that the generic position is established beyond doubt. Although the rounded form of the whorl and the impressed spiral grooves might suggest at first sight that we are dealing with a fragment of an immature *Neritopsis ? turbinata* Sharpe,* a comparison with Sharpe's specimens shows that this is not the case. The spiral ornaments lack the regularity, and the grooves are broader, less sharply incised and less regularly spaced than those of Sharpe's type. A complete comparison, it is true, is difficult, since the examples of *Neritopsis ? turbinata* preserved in the Geological Society's museum are all much larger than the fragmentary specimen here described, and the involution of Sharpe's shell is such that it is not possible to make satisfactory comparison at the same stage of growth; but the observable differences in the ornamentation are in themselves sufficiently significant.

Considerable resemblance is shown to a shell from the Neocomian of German East Africa described by G. Müller as *Delphinula africana*,† such similarity, in fact, as to suggest that we are dealing with a closely allied form. The shape and proportions of the body-whorl appear alike, and in each case there is the strong spiral groove on the lower part of the peripheral area. In the figure of *Delphinula africana* a spiral keel is seen, situated between this groove and the keel which defines the shoulder above. In the Dunbrodie specimen, which is of smaller dimensions than Müller's type, the beginnings of a similar keel, though weakly developed, are becoming apparent in the most advanced portion of the whorl. As regards other charac-

* Sharpe (1), p. 198, pl. xxiii., fig. 5.

† G. Müller (1), p. 557, Taf. xix., fig. 11.

ters, it is not easy to make a detailed comparison, and it must suffice to have drawn attention to the apparently close resemblance between these shells. In his employment of the generic name *Delphinula* for forms such as these, Müller follows the usage of Stoliczka. Fischer has restricted the use of the name to living types, but it has been applied to certain *Turbo*-like shells of Jurassic and Cretaceous age by several leading authorities.* In the case of the single specimen here dealt with, while it may be considered most expedient in the meantime to use the name *Turbo* as one of convenience, it appears not improbable that better preserved material may eventually show that a separation is necessary.

In the form of the whorl and the ornamentation great similarity is also shown to the figure of a specimen from the Aptian of Sainte-Croix, identified by Pictet and Campiche, perhaps wrongly, with *Turbo munitus* Forbes.† The African specimen is much smaller than this Swiss individual, but so far as a comparison with the figure is possible, the general agreement is very close. The specimen depicted by Pictet and Campiche in fig. 1 of the same plate has a taller spire and less expanded whorls than the original of fig. 3, and agrees much more closely with the typical *T. munitus* from the English Lower Greensand, and correspondingly less closely with this specimen from South Africa, apart from the differences in the ornamentation.

Genus NATICA Lamarck.

Natica uitenhagensis sp. nov.

Plate VIII., figs. 11, 11*a*; ? figs. 10, 10*a*.

Description.—The shell consists of at least five whorls. The spire is very short, the body-whorl overlapping rather more than one-half of the preceding whorl and expanding relatively rapidly; the body-whorl occupies rather more than two-thirds of the whole height of the shell. The spiral suture is somewhat deeply impressed though not definitely channelled; the upper part of each whorl, adjacent to the suture, is slightly flattened to form a narrow rounded ledge, as seen in profile, the outer limit of which is not sharply defined, but forms a curved outline passing down into the rather flattened upper half of the whorl. This flattening of the whorl above the middle zone is most marked in the body-whorl of a well-grown individual, and even a slight depression of the surface here may be developed

* See remarks by Hudleston and Wilson (1), p. 20; also Stoliczka (1), p. 368 (1868).

† Pictet and Campiche (1), 2e Partie, p. 480, pl. lxxxiv., figs. 3*a*–3*c* (1863).

during the fifth whorl. At the middle zone, and below, the whorl is evenly convex in outline.

The shell-wall is thick. The surface of the whorls is marked by numerous distinct, transverse growth-lines, which, however, do not form an obtrusive feature. The spiral angle is about 90°. The inner lip of the aperture is considerably thickened and forms a raised callus which bounds a well-impressed though closed umbilical slit. Just below this, and adjacent to the inner lip, the surface of the whorl presents a narrow, slightly flattened space. The height of the aperture is much greater than the breadth.

Dimensions.—	(1)		(2)
Height of shell	15	.	30 mm.
Height of body-whorl at the aperture	11	.	24 ,,
Greatest width at aperture	8	.	12 ,,

Occurrence.—Two well-preserved specimens in the collection of the Geological Society of London are labelled "Zwartkop, Dr. Atherstone, 1876." A specimen from the railway cutting between milestones 24½–24¾ on the railway from Uitenhage to Graaff-Reinet, about three miles from Uitenhage (350), is referred with some doubt to the same species.

Remarks.—The specimen from the railway cutting (350) may perhaps be identical with Atherstone's two individuals, upon which this species is founded. It differs from them by its rather lower spire and slightly wider spiral angle, and by the more complete overlapping of the whorls. These differences may, however, be due to individual variation.

Natica atherstoni Sharpe,* another Uitenhage shell, is distinguished by its much more slender and elongated figure and narrow apical angle (75°).

Compared at similar dimensions, *Natica lævigata* (Desh.) Leym.,† a Lower Cretaceous form, has much less overlap of the whorls, and consequently a higher spire and narrower spiral angle. *N. dupini* (Desh.) Leym.,‡ on the other hand, has a shorter spire and wider spiral angle, with wider and more inflated whorls and less elongated mouth aperture. The shell figured by d'Orbigny as *N. dupini* § shows much greater similarity to *N. uitenhagensis*, but this too has a wider spiral angle and a broader aperture as well as a distinct umbilical opening.

* Sharpe (1), p. 200, pl. xxviii., fig. 22.

† Leymerie (2), p. 13, pl. 16, fig. 10.

‡ Leymerie (2), p. 13, pl. 16, fig. 7.

§ d'Orbigny (2), p. 158, pl. 173, figs. 5, 6 (1843).

In form and outline and in the shape of the aperture great resemblance is shown to the shell from the Stramberg beds figured by Zittel * as *Natica* (*Ampullina*) *elegans* Sow.; this differs, however, by the slightly less overlap of the whorls and by the thinner shell; the inner lip is considerably less thickened than in the African form. It seems doubtful whether the Stramberg shell is identical with the English Portland *Natica* to which Sowerby gave the name *N. elegans*, and although Sowerby's figure † much resembles fig. 23*a* in plate 45 of Zittel's work, yet typical specimens of the Portland shell show a higher spire. *Natica uitenhagensis* is well distinguished from the English *N. elegans* by the much thicker shell and the lower spire. The shells from the "Portlandien supérieur" of Boulogne, ascribed to *Natica elegans* Sow. by de Loriol and Pellat,‡ whose determination was accepted by Hudleston and Wilson,§ are also slightly higher in the spire, and the aperture is broader and more rounded below.

The form described by Stanton as *Lunatia constricta*, from the Belgrano beds of Patagonia,|| shows great similarity to *N. uitenhagensis*, but differs apparently by the more strongly impressed sutures, the slightly less overlap of the whorls, and by the marked transverse furrows.

Natica rogersi sp. nov.

Plate VIII., figs. 12, 12*a*, 13, 13*a*.

Description.—The shell is small, and consists of four whorls in the specimens examined. The body-whorl overlaps a little less than one-half of the preceding whorl, and occupies about two-thirds of the whole height of the shell. The spiral suture is well impressed or slightly channelled. The whorl-surface traced downwards from the suture presents an evenly convex surface.

The shell-wall is rather thick. The surface is marked by numerous transverse lines of growth and there is also a tendency to produce coarser, rounded, transverse ridges and furrows. The spiral angle is about 90°. The mouth aperture is broadly rounded below and narrowed and somewhat pointed above. The height of the aperture does not greatly exceed the breadth. The outer lip is sharp. Below, the margin of the aperture is thickened. On the inner side

* Zittel (4), p. 289, Taf. 45, fig. 23.

† J. de C. Sowerby (2), p. 347, pl. xxiii., fig. 3.

‡ de Loriol and Pellat (1), p. 27, pl. iii., figs. 13–15.

§ Hudleston and Wilson (1), p. 81.

|| Stanton (3), p. 31, pl. vi., figs. 10, 11.

of the aperture is a well-developed callus. There is a slightly developed, short, closed umbilical slit.

Dimensions.—	(1)	(2)	(3)
Height of the shell	11	12	13 mm.
Height of the body-whorl at the aperture	8	8	9 ,,
Greatest width of aperture	6	5·5	6 ,,

Occurrence.—Found by Mr. Rogers in the cliff on Buck Kraal, Sunday's River (136h).

Remarks.—This form is distinguished from small specimens of *Natica uitenhagensis* sp. nov. by the rather more expanded and less elevated figure of the shell, and the broader and more rounded form of the aperture. A specimen from the neighbourhood of Uitenhage (350), ascribed above with some doubt to *N. uitenhagensis*, is comparable in point of size with individuals of *N. rogersi.* It differs from these by its broader apical angle, shorter spire, narrower and more elevated figure, and relatively higher body-whorl and aperture.

Natica ? mirifica sp. nov.

Plate VIII., figs. 14, 14*a*.

Description.—The shell consists of at least six whorls, and has a somewhat elongated turbinate outline with the body-whorl well produced and narrowed below. The body-whorl overlaps about half the preceding whorl, and occupies rather less than two-thirds of the total height of the shell. The spiral suture is well impressed, and below it the whorl-surface bulges out in the form of a convex spiral fold. Immediately below this rounded swelling of the whorl-surface is a depression of the surface forming a concave spiral band. This impressed zone is less well developed in the earlier whorls, more pronounced in character in the later ones. At the middle zone of the whorl the surface is again convex, and below this the whorl-surface slopes inwards with less marked convexity. The concave and convex zones in the upper half of the whorl merge into one another without the production of any angularities of the surface or of the outer lip of the aperture.

The shell-wall is moderately thick. The surface is smooth and only marked by transverse growth-lines. The spiral angle is about 70°. The aperture is elongated, its height being about twice as great as its maximum breadth. It is angular at its upper extremity and has a narrowed, rounded outline below. The inner lip is thickened and a callus is developed. There is a short, narrow, but closed umbilical slit.

Dimensions.—

Height of shell	27 mm.
Height of aperture	17 ,,
Greatest width of aperture	10 ,,

Occurrence.—Collected from the cliff on Buck Kraal, Sunday's River (137h). A fragment of a specimen, probably belonging to the same form, was obtained from the cliff W. 20 S. from Comley's house, right bank of Sunday's River.

Remarks.—This is a rather peculiar shell, and I am unable to state with certainty its true generic position. In spite of the elongated form, the relatively narrow spiral angle, the narrowed aperture, and the body-whorl produced and narrowed below, the characters of the shell appear on the whole to conform with those of naticoid type, while the close and smooth texture and lustrous appearance of the surface, when well preserved, seem to favour alliance with some division of the *Naticæ*. A striking feature of the shell is the longitudinal (spiral) depression of the surface of the whorls in their upper part. This character in less emphasised form is not unknown in *Natica*, though I am not aware that any described species exhibits it in such a marked degree as in the shells under discussion. The well-known *Natica bulbiformis* from the Gosau beds, figured by J. de C. Sowerby,* has a distinct depression of the surface corresponding in position with the stronger sulcation in this African form. *N. bulbiformis* also has a relatively tall spire, but it is otherwise well distinguished by its more cylindrical whorls, the deep channelling at the suture and the more oblique direction of the mouth in relation to the long axis of the shell. *Natica angulata* from the same beds,† first figured by Sowerby, also shows in some degree a corresponding depression in the surface of the whorls.

There is a very close resemblance between *Natica ? mirifica* and a Cretaceous gasteropod from the steppes of Astrakhan, described and figured by B. Rehbinder under the generic name *Odostomopsis.*‡ The general form of the shell and the undulating outline of the whorl-surface is strikingly similar, but generic identity seems excluded by the absence of any fold on the columella in the African form. It may be questioned whether the specimens depicted in Rehbinder's figures 12 and 13 are identical with the originals of any of the other figures given by him under the same

* In Sedgwick and Murchison (1), pl. xxxviii., fig. 13 ; see also Zekeli (1), p. 45, Taf. viii., fig. 2.

† Zekeli (1), p. 46, Taf. viii., fig. 4.

‡ Rehbinder (1), p. 139, pl. ii., figs. 12, 13.

specific name, and it is very doubtful whether they are correctly referred to *Odostomopsis abeihensis* (Blanck.), but it is certain that the Uitenhage form here ascribed with doubt to *Natica* cannot be brought into close comparison with Whitfield's genus.*

Genus ACTÆONINA A. d'Orbigny.

Actæonina atherstoni (Sharpe).

Plate VIII., figs. 15, 15*a*, 16, 16*a*, 16*b*.

1856. *Actæon atherstoni* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 200, pl. xxviii., fig. 19.

Supplementary Descriptive Note.—The shell consists of about six whorls, in the last of which there is a tendency to develop a steeply sloping and slightly convex shoulder below the suture, demarcated from the flattened central portion of the whorl by an ill-defined, blunt spiral ridge. The previous whorl also shows these characters, though in less marked degree, but the earlier-formed whorls have a more evenly rounded outline, most convex near the suture, more flattened below. The whorls are ornamented over their whole surface by numerous delicate, impressed, linear, spiral striæ which are crossed by more conspicuous furrows and rounded ridges of accretion, most noticeable in the last whorl. The spiral angle is about 45°.

Dimensions.—

Height of a specimen with six whorls.........	19 mm.
Greatest diameter of the last whorl............	9 ,,
Height of the aperture	10 ,,
Greatest width of the aperture..................	4·5 ,,

Occurrence.—Collected at Grass Ridge, three miles east-north-east of Uitenhage (333), and from a clay-pit in the lower part of the Marine Beds on the left bank of the Zwartkop's River near Rawson Bridge (343); also at Dunbrodie, Sunday's River (283, 284). Specimens from the South African Museum are from the Sunday's River. The record of occurrence given by Sharpe was "the lowest strata of the Zwartkop crag." Mr. Rogers collected specimens of this form in 1905 at the bare slope W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop, Sunday's River (24h); from the highest beds in a kloof behind Colchester, Sunday's River (499g); and from a cliff W. 20 S. from Comley's house, right bank of Sunday's River (92h). From this last locality was also obtained a specimen (95h)

* Whitfield (1), p. 425.

which may possibly belong to this species, though it possesses certain distinguishing characters which are noted below.

Remarks.—Sharpe's figured type, in the collection of the Geological Society of London, is an unsatisfactorily preserved immature specimen with the shell partially removed. The smallest example sent to me from South Africa measures 6·5 mm. in length, and is considerably larger than the figured type, but a careful comparison convinces me that these and the larger shells, one of which attains a length of 19 mm., represent the same form. All the specimens submitted to me have their whorls covered throughout with the delicate spiral striæ, and it was probably the imperfect preservation of his material which led Sharpe to believe that these markings are confined to the lower part. Relatively to the size of the whorls, the spiral ornamentation is strongest in youthful and early adult stages, weakest in the last whorl. A single specimen collected by Mr. Rogers (95h) differs from the majority of the individuals examined by its taller spire, narrower spiral angle and less inflated body-whorl: the degree of overlap in the whorls is also rather less, and the body-whorl occupies less of the total height of the shell (see plate viii., fig. 17). This may possibly represent a distinct species, but it bears so close a general resemblance to *A. atherstoni* that it is difficult to arrive at a decision on this point, especially as some variation is observable in the other individuals.

The examination of well-preserved adult specimens shows that this species possesses a mouth of oval form, rounded below, with sharp outer lip and a columella quite devoid of folds. It therefore falls within d'Orbigny's genus *Actæonina* as restricted by Meek,* under which name it was correctly quoted by Messrs. Rogers and Schwarz in their report on the survey of 1900.

There is some resemblance between *Actæonina atherstoni* and the Belgian shells ascribed by Briart and Cornet † to the Blackdown species named *Phasianella striata* by J. de C. Sowerby, and described under d'Orbigny's name *Phasianella sowerbyi.*‡ This has a shorter spire than the African form, but to judge from the figures given by the Belgian authors, the slender outline of the shell and the shape of the mouth are very similar, although the two forms are perhaps not even generically identical, and the striæ are coarser in the Belgian shell. In another Blackdown species, described by Sowerby under the name *Phasianella formosa,*§ the shape of the

* Meek (1), p. 91. † Briart and Cornet (1), p. 35, pl. iii., figs. 20, 21.

‡ d'Orbigny (4), vol. ii., p. 152.

§ J. de C. Sowerby (2), p. 343, pl. xviii., fig. 14.

whorls and the mouth closely approaches that of *Actæonina atherstoni*, but the spire of the English shell is relatively shorter, and the spiral striæ are confined to the lower part of the whorls.

A specimen from the Upper Cretaceous beds of Umkwelane Hill, Natal, has been described as a variety of *Actæonina atherstoni* by R. Etheridge, jun. (var. *umkwelanensis*).* To judge from the figure of this supposed variety, there is a general resemblance to *Actæonina atherstoni*, although the spiral striæ are depicted as of a coarser character than in the Uitenhage form. Mr. Etheridge's remarks on his new variety do not suffice to enable a satisfactory comparison to be made, but I am inclined to doubt the likelihood of near relationship between these forms.

Actæonina haugi Ascher, from the Grodischter Schichten,† the equivalent of the Hauterivian in Silesia, is of similar general type to *A. atherstoni*, and is ornamented over the whole surface of the whorls by minute spiral striæ. It is more slender and elongated, however, and more cylindrical in form, and has a narrower spiral angle and less convex whorls than *A. atherstoni*. The specimen numbered 95h, mentioned above, approaches closely to *A. haugi* in the form of the spire, but has a more convex and less cylindrical body-whorl.

Genus LIMNÆA Lamarck.

Limnæa remota sp. nov.

Plate VIII., figs. 18, 18*a*.

Description of a Single Specimen.—The specimen, which is imperfect at the apical end, consists of nearly four whorls, and is wound in the form of a tall spire, having a somewhat pupoid figure. The outline of each whorl slopes down very steeply from the spiral suture, giving the whorl a gently and evenly convex profile. The volutions are relatively high between the sutures. The body-whorl overlaps about one-third of the previous whorl, and occupies nearly one-half of the total height of the shell. The rather steeply inclined spiral suture is not deeply impressed.

The spiral angle is about 30°. The shell-wall is thin, and its outer surface is marked by numerous wrinkles and furrows of accretion. The mouth aperture is in the form of an acute angle above, and is of rounded oval outline below. Its height is about twice as great as

* Etheridge (1), p. 87, pl. ii., fig. 38.

† Ascher (1), p. 152 [18], Taf. xii. [i.], fig. 12*a–c*.

its breadth. The outer lip is thin and the inner lip only furnished with a very thin callus-coating.

Dimensions.—

Height of shell..................................	33 mm.
Height of body-whorl at the aperture ...	17 ,,
Greatest width of the aperture	8·5 ,,

Occurrence.—The specimen was collected by Mr. Rogers from the cliff on Buck Kraal, Sunday's River (138h).

Remarks.—This is the only fresh-water form included among the fossils found in the cliff-section on Buck Kraal, and it seems most probable that it represents a merely stray occurrence in marine strata, and does not indicate the presence of a fresh-water bed. The specimen may have become washed down into marine surroundings by flood-waters, but its fresh appearance suggests that it could not have been subjected for long to the action of currents before becoming embedded.

The resemblance shown by this specimen to *Limnæa longiscata* Brongn.,* which occurs so abundantly in the Headon Beds of the Hampshire basin and in the Paris basin, is really very striking. Although selected specimens of *L. longiscata* may approach very closely in all characters to the form with which we are dealing, yet this may be well distinguished from most specimens of the Tertiary shell by its more slender and elongated figure. The spiral angle of *L. longiscata* is frequently wider, and the body-whorl is almost always more tumid than in *Limnæa remota.*

Class CEPHALOPODA.

Genus PHYLLOCERAS E. Suess.

Phylloceras rogersi sp. nov.

Plate VIII., figs. 19, 19*a*–*c*.

Description of a Single Specimen.—The shell is very involute, with minute umbilicus. The umbilical wall is not abruptly marked off from the flank. The whorls have a laterally compressed form, and the flanks show a slightly convex surface. The height of the whorl, measured from the umbilical rim, is greater than the breadth seen in cross-section. The greatest breadth of the whorl-section occurs at

* Edwards (1), p. 85, pl. xii., figs. 3*a*–*h*; Deshayes (1), p. 92, pl. xi., figs. 3, 4 (1825).

about the middle of the flank, and from here the whorl narrows very gradually towards the periphery, which forms a relatively broad, flattened arch.

The surface is ornamented with closely set, delicate, linear transverse ribs, which have a very slight forward inclination when traced from the umbilicus towards the periphery. On a portion of the last whorl which measures 9 mm. from the umbilical centre to the periphery, there are 12 ribs crowded into a space of 2 mm. at the middle of the flank. There are no constrictions.

The specimen is imperfect, and is wholly septate. The course of the lobe-line is relatively complex in its details. The siphonal (external) lobe is narrow and very deep, and the small siphonal saddle at its termination narrows somewhat abruptly to a sharply pointed summit. The siphonal lobe is as deep as the first lateral lobe.

Dimensions.—

Greatest diameter, if completed, about...............	30 mm.
Greatest breadth of the last whorl in cross-section	16 ,,
Height of the last whorl at the centre, in section...	13 ,,

Occurrence.—Found in the kloof behind Colchester, Sunday's River Valley, in the middle beds (3h).

Remarks.—This specimen, so far as I am aware, is the only representative of the genus *Phylloceras* which has been found in the Uitenhage Series. It is, unfortunately, not a complete individual; the body-chamber is absent, and a portion of the last whorl preserved is also broken away. The surface ornaments are only preserved in a few small patches on the early part of the last whorl, where the outer surface has escaped destruction. In the remaining portions of the surface which are exposed, sufficient of the shell substance is present to prevent the septal suture-line from being seen. It has, therefore, been necessary to etch away part of the shell with acid in order to obtain a view of the suture-line, but owing to the mode of preservation of the cast, the picture obtained is not so satisfactory or complete as might be desired.

It has been possible, however, to trace the course of the lobe-line so far as concerns the siphonal lobe, the first lateral saddle and the first lateral lobe. The most striking feature is the depth of the siphonal lobe, which touches a radius which is reached by the first lateral lobe. In other respects the lobe-line, so far as observed, very much resembles that given by d'Orbigny in the case of his *Ammonites picturatus*,* from the Lower Neocomian of France; although both

* d'Orbigny (1), p. 178, pl. liv., figs. 4–6 (1841).

suture-lines are so complex, the agreement, in fact, is remarkably close. *Phylloceras picturatum* has somewhat less inflated whorls than the African form, and its surface is said to be entirely smooth.

In the depth of the siphonal and first lateral lobes of the septal suture, there is agreement with *Phylloceras semisulcatum* (d'Orb.)* but the suture of that form is much less complex in its details.

There is considerable similarity of form to a specimen from the Wernsdorfer Schichten (Barrêmian of Silesia) described by Uhlig under the name *Phylloceras* cf. *guettardi* Rasp.† The whorl-section of this shows that the flanks converge slightly towards the periphery, which is narrowly arched. In the African specimen the flanks are not so markedly convergent, but are more nearly parallel, and they are perhaps a little less convex. The peripheral area is broader, and in the cross-section of the whorl a greater breadth is maintained up to the peripheral part. There are no noteworthy points of agreement in the course of the septal suture of these two forms. In the shell described by Uhlig, which is said to have a suture identical with that figured by d'Orbigny for *Phylloceras guettardi*,‡ the siphonal and first lateral lobes are of unequal length, and the suture is considerably less complex in its details.

The specimen here described appears to represent a new species, but it will be necessary at some future time to supplement the present imperfect account by additional notes, and by the illustration of the septal suture of a more favourably preserved individual.

Genus BOCHIANITES P. Lory.

Bochianites glaber sp. nov.

Plate VIII., figs. 20, 21.

Description.—The shell has a delicately attenuated form, and increases very slowly in diameter. Near the delicately pointed posterior end the shell is cylindrical, but becomes slightly compressed laterally, with corresponding elliptical section, when traced towards the anterior end. The surface is devoid of ornamentation, and is marked by numerous minute lines of growth which show a slight anterior arching on the siphonal side, and when traced across the flank of the shell are directed somewhat posteriorly; they follow a straight course (or have an exceedingly gentle and broad

* d'Orbigny (1), pl. liii., fig. 6 (1841).

† Uhlig (1), p. 182, Taf. iv., fig. 9.

‡ d'Orbigny (1), pl. liii., fig. 3 (1841).

anterior arching) when passing across the anti-siphonal side. In addition to these lines there are very faint and indistinct shallow depressions of the surface, of varying breadth, which follow a course similar to that of the growth-lines.

It has only been possible to follow completely the course of the septal line at an early stage of growth, where the shell has a diameter no greater than 2 mm., and, as might be anticipated, the suture is here of a comparatively simple character. While the main lobes and saddles have come to full development as regards their general course, the minor indentations of the suture have only in small degree made their appearance. The siphonal, anti-siphonal, and lateral lobes are narrow and deep, and have almost equal elongation. At this comparatively early stage the trifid character of the lateral lobe is already making its appearance. Both the siphonal and lateral saddles are divided into two limbs by a narrow and shallow subsidiary lobe. Each limb of the saddle is in turn divided by a shallow, pointed indentation. The lateral saddle is slightly broader than the siphonal saddle. The small secondary saddle at the base of the siphonal lobe is at this stage weakly developed and has a blunt summit.

Dimensions.—

Length of a specimen with body-chamber, but incomplete at initial and anterior ends	50 mm.
Diameter at the posterior end	2 ,,
Greater diameter at the anterior end	5 ,,

Occurrence.—Found on the road below the railway cutting, one mile from Rawson Bridge on the main line, up side (277, 338). Crushed specimens obtained from the clay-pit on the left bank of Zwartkop's River near Rawson Bridge (278, 339, 344), referred by Messrs. Rogers and Schwarz with some doubt to *Baculites*, may probably represent the same form.

Remarks.—The adoption of the name *Bochianites*, proposed by P. Lory* for *Baculites neocomiensis* d'Orb. and its allies, seems to be well justified when a comparison is made between the septal sutures of the forms to which the name is applied and those of the true *Baculites* as exemplified, for instance, by *B. baculoides* (Mant.) or *B. bohemicus* Fritsch and Schloenbach. Whether we are to regard

* Lory (1), p. 133, footnote; Lory (2), p. 129, footnote. [I have not been able to consult the latter work quoted, but give the citation on the authority of von Koenen (2), p. 397, and G. Boehm (3), p. 26. The papers Lory (1) and Lory (2) have identical title and date of year, but I have not ascertained which was issued first; one is presumably a reprint of the other, except in pagination.]

Bochianites as a separate genus or as a sub-genus of *Baculites* might, perhaps, be considered doubtful, and on this point G. Boehm, who adopts the name,* has refrained from expressing an opinion. Sarasin and Schöndelmayer ascribe a generic value to the name, and consider that a comparison of the septal sutures indicates that *Bochianites* and *Baculites* have originated separately ; † the differences revealed by such a comparison are, in fact, so striking and so constant that with present knowledge it appears to be a reasonable and expedient course to regard these forms as generically distinct. In *Bochianites* there is a siphonal lobe, an anti-siphonal lobe, and on either side one main lateral lobe. These are relatively narrow and of almost equal depth. An important distinctive feature is the trifid termination of the lateral lobe. On either side there are two relatively broad saddles, each divided fairly symmetrically by a narrow subsidiary lobe. There are thus typically only four main lobes and four saddles, though in some forms (for example *B. undulatus* von Koenen) the lateral saddle is so deeply divided that it might be almost regarded as forming two saddles separated by a lobe less deep than the lateral lobe. To obtain the septal suture of *Baculites*, we must imagine the subsidiary lobe of the lateral saddle to be so deepened as to constitute an additional lateral lobe ; at the same time the anti-siphonal lobe becomes very much less deepened, while the first lateral lobe should have a paired instead of a trifid termination. These relations are very well revealed by a comparison of the suture-line in *Bochianites neocomiensis* ‡ and *Bochianites wateringi* § with that in *Baculites baculoides* || and *Baculites bohemicus*.¶

There can be no doubt that the Uitenhage specimens must be referred to *Bochianites*, as clearly indicated by the course of the lobe-line. One of the chief distinctive characters of the form here dealt with appears to be the absence of surface ornaments, and even allowing for imperfect preservation, it may be regarded as certain that the available material would have shown definite traces of ribbing if such had existed. Specimens from the clay-pit near Rawson Bridge, which I think may represent the same species, are much crushed, but the shell-substance is in great part preserved and retains its nacreous lustre. In these there is no trace of ribbing, and the shell appears to have been a smooth one.

* G. Boehm (3), p. 26. † Sarasin and Schöndelmayer (1), p. 177.

‡ d'Orbigny (1), p. 560, pl. 138, fig. 4 (1842).

§ G. Boehm (3), p. 26, fig. 3. || d'Orbigny (1), p. 562, pl. 138, fig. 11 (1842).

¶ Jahn (1), pl. viii., fig. 7 ; Woods (1), p. 76, pl. ii., fig. 10.

A form with which it might seem possible to bring *Bochianites glaber* into close comparison is *B. oosteri* Sarasin and Schöndelmayer,* from the Swiss Neocomian. This is also devoid of ornamentation so far as has been ascertained; but it appears to be well distinguished by the great breadth of the lateral saddle in relation to the siphonal saddle, and by the deeply divided form of the lateral saddle. This division is carried so far, indeed, that it may be said that two lateral saddles are developed. If *B. glaber* possessed in maturity a septal suture having the relations of lobes and saddles similar to those exhibited in *B. oosteri*, it would be right to expect that some signs of it would be evident even at an early stage. Traces of the suture of *B. glaber* where the shell has attained a diameter of 4 mm. are still of a very simple character, and show no promise of such sub-division at a later stage of growth as that which characterises the mature *B. oosteri*. Moreover, the septa of *B. glaber* are much more closely approximated than those of the Swiss shell, in which the length of the chambers is a special feature.

Bochianites undulatus von Koenen,† from the lower Aptian of North Germany, is well distinguished from *B. glaber* by the well-developed ornamentation and the deeply divided lateral saddle, as well as by other features.

Baculites rotundus Reuss,‡ from the Plänermergel of Bohemia, is also a smooth, slowly tapering form, but without particulars of the septal line it is impossible to make a close comparison. *B. rotundus* may be a true baculite, and Pictet has even suggested that its real position may be in the genus *Hamites*.

Genus HOLCOSTEPHANUS M. Neumayr (*sensu stricto*).

The great majority of the ammonites included in the collections under examination belong to that section of the original genus *Holcostephanus* exemplified by d'Orbigny's *Ammonites astierianus*, the form which was regarded by Neumayr to be the best known typical species of his genus.§ To this species and some allied forms Pavlow gave the name *Astieria*, when recognising that the wide application of the name *Holcostephanus* was not in accordance with

* Sarasin and Schöndelmayer (1), part 2, p. 179, pl. xxiv., figs. 3, 4, and text-figure 6.

† von Koenen (2), p. 398, pl. liii., figs. 11, 13, 14.

‡ Reuss (1), part i., p. 24, pl. vii., fig. 4 (1845).

§ Neumayr (1), p. 922.

the results and requirements of modern work, and that a division into a number of genera or sub-genera had become necessary.* If we were to ascribe to the name *Holcostephanus* the broad signification allowed by Neumayr, Zittel, and others, it would certainly be convenient to use the name *Astieria* to denote one of several sub-genera, were this procedure not contrary to the recommendations of the International Zoological Congress.† It will be more correct, as Lemoine has pointed out, to restrict the name *Holcostephanus* to that portion of the genus, as originally conceived, which is typified by *H. astierianus*, and apply it in place of *Astieria.*‡

The separation of *Spiticeras* from Pavlow's *Astieria*, as proposed by V. Uhlig and F. Suess, appears to be a well-founded step in the recognition of further divisions within the broadly conceived genus *Holcostephanus*. *Holcostephanus*, sensu stricto (= *Astieria* Pavlow, emend. V. Uhlig and F. Suess) thus becomes a group having very narrow limits, and some division of opinion is likely to exist concerning the question of its generic or sub-generic value. This at present must remain a matter for individual judgment, and in view of our rapidly growing knowledge and the other causes which contribute to the present instability of ammonite-classification, it is a question of comparatively subordinate importance. For the purposes of the present work the name will be employed in a generic sense, as the equivalent of the restricted *Astieria* of Uhlig and F. Suess.

It is unfortunate that the specimens of *Holcostephanus* obtained from the rocks of the Uitenhage Series are usually in a state of preservation unfavourable for exhaustive study. Thus, in no case has it been possible to ascertain the true course of the lobe-line, while evidence regarding the form of the body-chamber and mouth aperture is likewise still scanty. We must also look to further collecting to furnish materials for a study of individual development in the various forms represented, and it is clear that there is much to be added in order to supplement the following imperfect account of this interesting assemblage. There can be no doubt, however, that the characters of shape and ornament displayed by the available specimens suffice to enable us to read aright the relationships of these forms, though perhaps not always with the precision that might be desired.

It may be pointed out that in the diagnosis of *Astieria* given in Uhlig's monograph on the Fauna of the Spiti Shales § a sentence

* Pavlow and Lamplugh (1), pp. 471, 491 (113, 133 of authors' copy).

† Règles Internationales de la Nomenclature Zoologique adoptées par les Congrès Internationaux de Zoologie; articles 9, 25, 29. Paris, 1905.

‡ Lemoine (1), p. 181.

§ Uhlig (4), p. 86.

occurs which does not seem to express quite accurately the relations most frequently exhibited in the secondary ribbing. It is stated that, starting from the tubercles at the margin of the umbilical wall, there are groups of secondary ribs " which bifurcate higher up and admit of intercalary ribs." It would perhaps have been more correct to say that bifurcation of the secondary ribs on the flank (away from the tubercles) occurs rather as an exception than as a rule, since it is certainly either absent or very rare in the majority of known "*Astieriæ.*" In typical specimens of *H. astierianus* (d'Orb.), as figured by d'Orbigny himself,* no bifurcation in the costæ of the rib-bundles after they leave the tubercles is apparent, but the finely ribbed forms (d'Orbigny's plate 28, fig. 4), which have been named *H. sayni* by Kilian and *Astieria scissa* by Baumberger, show the division of the ribs here and there on the flank. In all the South African representatives of *Holcostephanus* the groups of secondary ribs proceed from the compressed umbilical tubercles and pass over the periphery to the tubercles of the other side without undergoing any division. It may be noted, however, that the ribs forming a group on one flank may become so disposed when traced to the opposite flank that they do not all reunite at one tubercle; thus, of three ribs departing from a tubercle on one side, two may unite again at a tubercle on the opposite side of the whorl, while one may either pass to an adjacent tubercle or may terminate in the space between two tubercles at the umbilical rim.

There is one other point in Uhlig's diagnosis of *Astieria* which seems to call for emendation. It is stated that the ornamentation " consists of a varying number of primary costæ which start from the suture, and at the passage from the umbilical wall into the sides swell up into tubercles." A specimen obtained by Messrs. Rogers and Schwarz near Uitenhage, and described below (*H. uitenhagensis* sp. nov.), is so characterised that it can only be ranged among the "*Astieriæ*"; but in this example the ornamentation commences with the marginal tubercles, and no primary umbilical costæ are developed in the last whorl. It seems therefore necessary to say that although primary umbilical ribs are present in the majority of the *Holcostephani*, yet they do not form an essential part of the sculpture in all growth-stages. It may be that in the specimen referred to, umbilical ribs were developed in the earlier growth-stages represented by the inner whorls, but these, owing to unfavourable preservation, unfortunately cannot be studied. In this specimen, which is of considerable size, the ultimate whorl probably represents a stage approaching, or in,

* d'Orbigny (1), p. 115, pl. 28, fig. 1 (1840).

the final phase of individual growth, and it is only in this whorl that the umbilical wall has been satisfactorily exposed and freed from the matrix.

The predominance of *Holcostephani* in the cephalopod-fauna of the Uitenhage beds is no less striking than the manner in which certain of these lend themselves to close comparison with European forms. There is apparently near relationship to types well distributed in the Valanginian and Hauterivian of the European continent and more sparingly represented in England, and in this fact we may recognise the most reliable evidence for a correlation of the Uitenhage Marine Beds with European standards. It will be well, for the present, to regard with the greatest caution the apparently peculiar geographical distribution of *Holcostephanus*, since so little is yet known of any cephalopod-faunas, in tropical or subtropical latitudes, which may be brought into correlation with that of the Uitenhage Series. Some remarks on this subject have already been made in the previous section of this memoir.

I have to acknowledge my indebtedness to Mr. G. C. Crick for kindly assisting me to compare some of the specimens described below with representatives of *Holcostephanus* preserved in the British Museum (Natural History).

HOLCOSTEPHANUS ATHERSTONI (Sharpe).

1856. *Ammonites atherstoni* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 196, pl. xxiii., fig. 1.

1882. *Olcostephanus atherstoni* M. Neumayr, in E. Holub and M. Neumayr, Denkschr. d. k. Akad. Wiss., Math.-Nat. Cl., Band xliv., p. 272.

1892. *Olcostephanus* (*Astieria*) *atherstoni* A. P. Pavlow (*partim*), in A. P. Pavlow and G. W. Lamplugh, Bull. Soc. Imp. Nat. Mosc., année 1891, Nouv. Sér., tome v., p. 495 (p. 137 of authors' copy). (Probably not pl. xvii., fig. 14.)

Occurrence.—Collected by Miss M. Wilman at Coega. A specimen from the South African Museum is probably from the Sunday's River. The type-specimen in the Geological Society's collection in London is from the Sunday's River (registered 10975). Messrs. Rogers and Schwarz have recorded this form from the Zwartkop's River valley in the neighbourhood of Uitenhage.* Mr. Rogers has also noted its occurrence at several localities in the valleys of the Coega and Sunday's Rivers. †

* Rogers and Schwarz (1), p. 9. † Rogers (2).

Remarks.—Some characteristic points in *H. atherstoni* are the strong, backwardly directed umbilical ribs, the steep umbilical wall, the relatively narrow and profound umbilical cavity, and the considerable breadth and inflation of the whorls. The involution until the shell has attained large dimensions is such that the umbilical wall of a given whorl falls upon the umbilical tubercles of the previous whorl, wholly concealing the secondary ribbing. In the large type-specimen of *H. atherstoni*, measuring 140 mm. in greatest diameter, the last-formed whorl is beginning to show a little less involution, and its most advanced part leaves the tubercles of the previous whorl wholly exposed, and also the commencement of the rib-bundles of the flank.

It has been stated by several authors that *H. atherstoni* occurs in the Valanginian and Hauterivian of Europe, and since such an occurrence would be of high interest, both from a stratigraphical and palæontological point of view, I have taken some pains to test the value of these identifications. The result has been to convince me that none of the determinations can be upheld with certainty.

Pavlow considered *Holcostephanus psilostomus* Neum. and Uhlig,* from the Neocomian of North Germany, to be identical with *H. atherstoni*, or at least that the two forms represent no more than varieties of a single species. Uhlig, on the other hand, believes this view to be erroneous,† and points out that *H. atherstoni* has an almost semicircular cross-section and greater breadth. There can be no doubt that, though closely comparable, these types are not identical. Another allied North German form, from the zone of *Hoplites radiatus* (Lower Hauterivian) has been described and figured by von Koenen ‡ under the name *Astieria* aff. *psilostoma.* In this, the rate of increase in the breadth of the whorls is not so rapid as in *H. atherstoni*, and the ribbing is a little coarser. The pronounced development of constrictions is another distinguishing feature.

Another European form which bears considerable resemblance to *H. atherstoni* has been described by von Koenen as *Astieria convoluta* § from the Lower Hauterivian of North Germany. This appears to have similarly inflated whorls and a narrow umbilicus, but the number of umbilical tubercles is fewer than in *H. atherstoni* at a comparable stage of growth, and the ribs are coarser and less numerous.

* Neumayr and Uhlig (1), p. 149, Taf. xxxii., fig. 2.

† Uhlig (4), p. 132.

‡ von Koenen (2), p. 151, Taf. liv., fig. 2.

§ von Koenen (2), p. 146, Taf. xxxix., figs. 4*a*, 4*b*.

Holcostephanus multiplicatus Neum. and Uhlig (non Roemer) * from the Upper Valanginian of North Germany, which has been renamed *Astieria ventricosa* by von Koenen, † approaches *H. atherstoni* in the fine character of the ribbing, but is well separated by the much higher whorl-section and the conspicuous development of constrictions, as well as by other characters.

Certain forms occurring in the south-east of France and in the Maritime Alps, ascribed by Kilian to *H. atherstoni*, ‡ seem to have been so named in the belief that *H. multiplicatus* Neum. and Uhlig (= *Astieria ventricosa* von Koenen) is identical with *H. atherstoni*. Baumberger has also spoken of the "Zone of *Holcostephanus multiplicatus* Neum. and Uhlig, non Römer = *H. atherstoni* Sharpe" in the Lower Hauterivian of the Swiss Jura. § Early in the present year, however, he has taken pains to show that the earlier identification of *H. multiplicatus* with *H. atherstoni* was erroneous. ||

When we come to discuss the correctness of Baumberger's view that a group of forms represented richly at the base of the Hauterivian (the so-called *Astieria* Zone) in the Swiss Jura is really inseparable from *Holcostephanus atherstoni*, the difficulty of forming a final judgment becomes very great. Baumberger discusses the question in great detail, ¶ and his conclusion is put forward judicially and not with any claim to be the final word in the matter. Some, at least, of the specimens figured by Baumberger bear a strikingly close resemblance to *H. atherstoni*, and it appears safe to conclude that the relationship is a very close one. It appears possible that more than a single species is represented in the Swiss material brought together by Baumberger under Sharpe's specific name, but I am not in the position to form a definite judgment on this point. Of the larger specimens figured by Baumberger, which from their size are most fitly comparable with the large type-specimen from South Africa, that depicted in plate xxiv., fig. 2, seems to agree most closely in the fineness of the ribbing. The specimen shown in plate xxiii., fig. 1*a*, exhibits more clearly the characters of the umbilical part of the shell, and allowing that this is an internal cast, the figure might well have been drawn from a South African specimen. The apertural view (fig. 1*b*), however, unless the peripheral part is much crushed down, shows that

* Neumayr and Uhlig (1), p. 150, Taf. xxxiii., fig. 2.

† von Koenen (2), p. 144.

‡ Kilian (1), pp. 716, 726, 735; Kilian (4), p. 865; Kilian and Leenhardt (1), pp. 973, 979, 981; Matte (1), p. 151.

§ Baumberger (1), 2er Theil, p. 3.

|| Baumberger (1), 4er Theil, p. 40.

¶ Baumberger (1), 4er Theil, pp. 39–47 (*Astieria atherstoni*).

the whorl is not nearly so highly arched in section as in *H. atherstoni*. In this character, the specimen shown by Baumberger in his text-figure 115 agrees more closely. The whorl-section shown in fig. 114, on the other hand, is not quite so highly arched in proportion, and seems to agree better with that shown by the South African specimens described below as *H.* cf. *atherstoni*. As regards the development of constrictions, these, if truly developed, are so inconspicuous in South African specimens that they can scarcely be detected, and they never form a feature like that shown in Baumberger's text-figure 116.

It must be admitted that much remains to be known about the true *H. atherstoni*. As yet, we are without information regarding the limits of individual variation, the characters of shape and sculpture in successive growth-stages from early youth onwards, and the course of the septal suture throughout the individual development. This information can only be obtained by the examination of an extensive suite of specimens, and in the meantime it is not possible to form a decided opinion on the question of identity with the Swiss specimens dealt with by Baumberger. It seems necessary, with the present imperfect data for comparison, to regard that question as still awaiting settlement. At the same time, we may presume the relationship between these Swiss and South African forms to have been so intimate as to furnish further highly suggestive evidence for a correlation between the Uitenhage beds and the strata situated about the base of the Hauterivian in Europe.

It may be noted that Baumberger gives reasons for considering that the form from the Hauterivian of the Maritime Alps ascribed by Kilian * to *H. atherstoni*, is not identical with the supposed *H. atherstoni* from the Swiss Jura, above discussed.

It has been stated by Sayn and Roman that *Holcostephanus atherstoni* occurs in the Hauterivian inférieur at localities in Languedoc.† In answer to an inquiry concerning this French form, M. Roman very courteously sent me three specimens from the Lower Hauterivian of Saturargues (Herault) which had been determined by M. Kilian. Two of the specimens were named *H. atherstoni*, and the third, a very finely ribbed example, somewhat flattened laterally by crushing, bore the name *H. sayni* Kilian. After a careful examination of these three specimens I was unable to satisfy myself that they represented two separate species. All three are very finely

* Kilian (4), p. 865, pl. lvii., fig. 1.

† Sayn and Roman (1), pp. 623, 625, 629, 632, 638, 639.

ribbed, and though the ribs seemed most crowded in the specimen referred by M. Kilian to *H. sayni*, yet the differences in this respect did not appear to me to be at all considerable, and other points of distinction, such as the more discoidal form, were probably to be accounted for by distortion through crushing. A comparison of these specimens with Sharpe's type, and other examples of *H. atherstoni*, shows that in *H. atherstoni* the shell is much more inflated and less discoidal: the whorl is broader in section and less highly arched. The umbilicus is relatively much narrower and more profound. The umbilical wall falls more abruptly and steeply into the umbilical cavity. The involution is greater. In the French specimens the umbilicus is of a broader and shallower type, and the involution is such that the tubercles, together with part of the ribbing of the flank, are visible in the penultimate whorl. The involution, in fact, is less than in the last whorl of the considerably larger type-specimen of *H. atherstoni*. The primary (umbilical) ribs are also much more weakly developed than in *H. atherstoni*. The ribbing of the flank and periphery of *H. atherstoni* is of a somewhat coarser type, and the ribs are rather more prominent and are less closely crowded together than those of the French specimens. At a selected stage of growth comparable in the two forms, a space of 20 mm. along the periphery includes 9 ribs in *H. atherstoni* and 13 in the French shells. In *H. sayni* an occasional bifurcation of a rib, or the intercalation of a shorter rib between two longer ones, may be observed to occur on the flank at a varying but usually considerable distance away from the tubercles. In *H. atherstoni*, the ribs of the flank all have their commencement either at, or in the near vicinity of, the tubercles, and bifurcation of the ribs has not been observed on any part of the flank.

It is clear, therefore, that these French specimens are not very closely comparable with *H. atherstoni*, and I think it highly probable that all three represent *H. sayni* Kilian,* a finely ribbed species very nearly allied to *H. astierianus* (d'Orb.).

A specimen from the Neocomian of Speeton (zone of *Belemnites jaculum*), preserved in the Scarborough Museum, was figured by Pavlow (*Bull. Soc. Imp. Nat. Mosc.*, 1892, pl. xvii., fig. 14) and considered by him to be identical with *H. atherstoni*. Through the kindness of Mr. H. Ascough Chapman and Mr. J. A. Hargreaves, of Scarborough, I have been able to compare this Yorkshire individual with Sharpe's type and other examples of *H. atherstoni* from South

* Kilian and Leenhardt (1), p. 976; Sarasin and Schöndelmayer (1), part 1, p. 38, pl. iv., figs. 2, 3; d'Orbigny (1), pl. 28, fig. 4.

Africa. The specimen is preserved unfavourably for an exhaustive comparison, but certainly bears a very close resemblance to *H. atherstoni*, particularly in the inflation of the whorls and the general character of the ribbing. Some readily apparent differences may at the same time be noticed. At a comparable stage of growth the Speeton form is distinctly more closely and more delicately ribbed; umbilical ribs are hardly defined, and certainly have not attained the development to be observed at a similar stage in *H. atherstoni*. A further point is that in all specimens of *H. atherstoni* the flattened umbilical marginal tubercles have either a slight backward direction when traced towards the flank, or their disposition is strictly radial; in the Yorkshire example, on the other hand, the tubercles have a strong forward inclination. These differences cannot be overlooked, and they strongly suggest that the Speeton form may not be identical with that from South Africa; but it must be admitted that the two approximate very closely to one another. It may suffice to have drawn attention to these points of difference while refraining from any final expression of opinion concerning the intimate relationship of these forms—a question which can only be ultimately settled by the comparison of further material. At the same time, I am inclined to think that the Speeton form will not be found to be identical with *H. atherstoni*.

Other finely ribbed specimens from the lower part of the zone of *Belemnites jaculum* at Speeton, which have been referred by Prof. Pavlow and Mr. C. G. Danford to *Holcostephanus astierianus* (d'Orb.), are also in some respects comparable with *H. atherstoni;* but they are usually of small size, and a satisfactory comparison with the much larger available examples of *H. atherstoni* is difficult. One such individual, in which the development of constrictions does not form a feature, has been figured by Mr. Danford under the name *Olcostephanus* (*Astieria*) *astieri*.* It is laterally compressed and relatively highly arched, and the umbilical ribs are very weakly developed and are not backwardly inclined. The secondary ribbing, which is of a very crowded and delicate character, has a stronger forward inclination than that of *H. atherstoni*. The tubercles also have a forward inclination, which is not the case in the African species.

Karakasch has described a *Holcostephanus* from the Lower Cretaceous of Biassala (Crimea) under the name *Holcostephanus* (*Astieria*) cf. *atherstoni* Sharpe.† It appears, from the figure given

* Danford (1), pl. xi., figs. 7, 7*a*.

† Karakasch (1), p. 103, pl. i., fig. 3.

by Karakasch, to differ from the African species by the relatively wider umbilicus and less degree of involution, but to resemble it in possessing backwardly inclined umbilical ribs. Kilian has described an ammonite from the Hauterivian of the neighbourhood of Escragnolles (Maritime Alps) as *Holcostephanus guebhardi*,* and states that this corresponds to *H. atherstoni* Karakasch, but not to the type of Sharpe. In the specimen figured by Kilian the ribs of the flank are strictly radial in direction, so that there is no close agreement with *H. atherstoni*.

Another form which may be somewhat nearly related to *H. atherstoni* is *H. schenki* (Oppel), from the Spiti Shales in Tibet,† but this is less densely ribbed and is further distinguished by the more flattened arch of the whorl-section, and by the presence of strongly marked constrictions.

An inflated form from the so-called "Gault" on the Island of Chasik and from Tukusitnu Bay (Alaska), figured by Eichwald as "*Ammonites astierianus* d'Orb. aff." and compared by him with Roemer's *Ammonites multiplicatus*, may perhaps be related to *H. atherstoni*; but according to Eichwald's insufficient figure the primary ribs are almost exactly direct (radial) in their course. A complete comparison with this unsatisfactory figure is impossible, since a side view only is given.‡

HOLCOSTEPHANUS cf. ATHERSTONI (Sharpe).

A single specimen from the Sunday's River, in the collection of the South African Museum, agrees very closely with Sharpe's type in all points except one—the inflation of the shell. The whorl-section has rather greater breadth in relation to its height, and the peripheral area presents a more broadly rounded surface and is less highly arched in sectional view than that of *H. atherstoni*. The shell accordingly retains a rather more globose aspect, the flank of the whorl is less extensive and less flattened and becomes more insensibly merged in the broad peripheral area, while the umbilical cavity is correspondingly rather more profound. The dimensions of the specimen, which comprises a considerable part of the body-chamber, are as follows:—

Greatest diameter	130 mm.
Greatest breadth of the last whorl in cross-section (estimated)	95 ,,

* Kilian (4), p. 866, pl. lvii., figs. 2*a*, 2*b*.

† Oppel (2), p. 286, Tab. 81, figs. 4*a*–4*c*; Uhlig (4), p. 130, pl. xviii., figs. 2*a*–2*c*.

‡ Eichwald (2), pl. viii., fig. 13.

Greatest height of the last whorl at the centre, in section 35 mm.
Greatest diameter of the umbilicus, measured from the umbilical rim between the tubercles .... 48 ,,

In the type-specimen of *H. atherstoni* the maximum diameter is 140 mm., the greatest breadth of the last whorl 90 mm., and the height of the last whorl in section at its anterior part 42 mm. It is thus seen that the height of the whorl-section in relation to its breadth is somewhat different. In the more inflated specimen, when the breadth of the whorl is 86 mm. its height at the centre is 32 mm.; in *H. atherstoni* (type-specimen) I have estimated that with a breadth of 86 mm. the height is 40 mm. The two left-hand specimens, depicted in greatly reduced size, in a text-figure published by Drs. Hatch and Corstorphine,* may perhaps represent this inflated form.

Mr. G. C. Crick has shown me a specimen in the British Museum (registered 46534) which closely agrees with the one here discussed. It is from the Sunday's River (from A. G. Bain's collection), and has at some time been determined as *Olcostephanus atherstoni*. It has an inflated form and breadth of whorl-section which seem to distinguish it from *H. atherstoni*, as exemplified by Sharpe's figured type, in the manner described above in the case of the other specimen. The greatest diameter of this individual in the British Museum is 145 mm. The greatest breadth of the ultimate whorl would, when complete, have been almost 100 mm., while the height of this whorl at the centre at its anterior end would have slightly exceeded 35 mm. In the breadth of the umbilicus and in all other characters there is the closest agreement with the specimen from the South African Museum. This would seem to indicate that fixed and reliable characters are exhibited which may suffice to separate this more globose shell from the true *H. atherstoni*, and it might perhaps be possible to establish the constancy of these distinctive features were a suite of specimens of undoubted *H. atherstoni*, at a suitable stage of growth, available for comparison. Unfortunately this is not the case, and the only specimen of *H. atherstoni* that I have seen which illustrates a comparable stage is Sharpe's figured type. Comparison with this has revealed the slight shape differences above noted, but beyond this there is entire agreement; the characteristic ornamentation, the degree of involution and the width of the umbilicus are the same. There is as yet no material for a comparison of the septal sutures. I therefore do not yet feel justified in proposing a new specific name for the specimens here

* Hatch and Corstorphine (1), p. 243, fig. 65 (as *Olcostephanus bainii*).

dealt with, and whatever may ultimately become known regarding their exact relationship to *H. atherstoni*, which they so closely resemble, it is certain that so far as present evidence goes, this relationship must be presumed to be very intimate.

Holcostephanus wilmanæ sp. nov.

Plate IX., figs. 1, 1*a*.

Description of a Single Specimen.—The shell is laterally much compressed and is discoidal in form; the flattened flanks of the ultimate whorl are relatively extensive, while the peripheral area is narrow and presents a somewhat flatly convex surface. The whorl is narrow and highly arched in section, and the height of the whorl-section, measured at the middle, is almost equal to the breadth, which is greatest at the umbilical margin. The whorl, however, is almost parallel-sided, so that the breadth of its section taken at the middle of the flank is little less than at the umbilical tubercles. The involution is such that about two-thirds of the preceding whorl are embraced.

The umbilicus is relatively shallow, and occupies one-third of the total diameter. The umbilical rim is not abruptly defined, but the surface of the flank curves down somewhat gradually to the umbilical wall, which falls very steeply to the spiral suture. Primary umbilical ribs commencing at the suture slope back very obliquely, and, quickly gathering strength, swell up at the umbilical rim to form strong, elongated, much-compressed tubercles, present to the number of eighteen in the ultimate whorl. The secondary ribs proceed from the tubercles chiefly in groups of three, but there are occasionally four ribs in a group in the ultimate whorl, and frequently a rib is inserted so as to terminate between two tubercles. The ribs at first swing forwards from the tubercle, and bend back at the middle of the flank to take an almost direct course across the periphery. The ribs are prominent in character, and on the peripheral area in the anterior part of the last whorl their crests are 4 mm. apart.

Immediately behind the oral margin is a strong constriction, and a portion of a lateral auricular extension is preserved.

Dimensions.—

Greatest diameter	90 mm.
Greatest breadth of the last whorl in cross-section............	30 ,,
Height of the last whorl at the centre, in section..............	28 ,,
Greatest diameter of the umbilicus, measured from the umbilical rim between the tubercles	30 ,,

Occurrence.—The specimen is in the collection of the Geological Society of London (registered 10975A), and the label affixed to it bears the following record of locality and collector: "Aasvogel Krantz above Modder Drift, Sunday's River, S. Africa. Dr. Atherstone, F.G.S., 1876."

Remarks.—The individual above described is almost complete, comprising the body-chamber, but the exact length of this cannot be ascertained, nor is the shell so preserved that the lobe-line is anywhere visible. The specimen has undergone some distortion from crushing, but making every allowance for this, it is clear that we are dealing with a form well distinguished by its high whorl-section and extensive flattened flanks. In the discoidal form, the relatively shallow umbilicus, and the degree of involution, we are reminded of *H. astierianus* (d'Orb.),* but *H. wilmanæ* is readily separated from this by its very strong, oblique umbilical ribs and tubercles, and by the inclination and the coarseness of the secondary costæ.

This appears to be the specimen mentioned by Pavlow † as a compressed variety of *H. atherstoni*, but it was recognised that the distinctive characters are sufficient to warrant a new specific name (*op. cit.* p. 492). As pointed out by Pavlow, the specimen is distinguished from the typical *H. atherstoni* by the presence of rather fewer umbilical ribs and by the more strongly developed secondary costæ. In addition, *H. atherstoni* is a considerably more strongly inflated shell, and has a relatively narrower and much more profound umbilicus. The points of distinction are in fact so great that the only course open is to definitely separate the two forms.

There is much stronger resemblance to *H. psilostomus* Neum. and Uhlig,‡ from the Neocomian of North Germany. The ribbing is of very similar character, but in *H. psilostomus* the umbilical ribs are rather more numerous, the breadth of the umbilicus is somewhat greater relatively to that of the flank, and the shell, although much more laterally compressed than *H. atherstoni*, is still considerably more inflated and less discoidal than in *H. wilmanæ*. I believe that the presence of the above characters of distinction must be considered sufficient to warrant the provisional separation of these two forms, but there can be little doubt that the relationship is intimate, and there is no other known *Holcostephanus* with which *H. wilmanæ* can be brought into such close comparison.

* d'Orbigny (1), p. 115, pl. 28, fig. 1 (1840).

† Pavlow and Lamplugh (1), p. 496 (p. 138 of authors' copy).

‡ Neumayr and Uhlig (1), p. 149, Taf. xxxii., fig. 2.

A shell from the Lower Hauterivian of North Germany described by von Koenen * under the name *Astieria* aff. *psilostoma* also shows great similarity to *H. wilmanæ*, but may be readily distinguished by the wider umbilicus, the strongly developed constrictions, and the more inflated and less discoidal form of the whorls.

Pavlow thought that small specimens from the Neocomian of Spain, figured by Nicklès † as *Holcostephanus hispanicus*, might possibly belong to this form; but though a thorough comparison with these figures is difficult, and the character of the ribbing appears to be very similar, it seems to me most probable that the much greater inflation of the Spanish shell would be found sufficient to separate it. If the specimen figured by Nicklès in fig. 11 represents the same form as that depicted in fig. 3, then it is clear that *H. wilmanæ* is a much more discoidal shell. The small specimen represented by Nicklès in fig. 10 is only drawn in side view, but it appears to possess a prominence of the umbilical rim and a depth of the umbilical cavity which may be taken to indicate the somewhat strongly inflated character of the shell. Pavlow draws attention to the existence of two specimens which he identifies with the South African form above described; the one is from Aigles (Basses-Alpes), preserved in the Pictet collection in the museum at Geneva, and the other, from the Shasta group of California, is in the geological collection of the University of Moscow.

Holcostephanus tönsbergensis (Weerth), ‡ from the Neocomian of the Teutoburger Wald, may possibly also be related, so far as can be judged from a comparison with Weerth's figure 4.

Holcostephanus baini (Sharpe).

1856. *Ammonites bainii* D. Sharpe, Trans. Geol. Soc. Lond., ser. 2, vol. vii., p. 197, pl. xxiii., fig. 2.

1882. *Olcostephanus baini* M. Neumayr, in E. Holub and M. Neumayr, Denkschr. d. k. Akad. Wiss., Math-Nat. Cl., Band xliv., p. 272.

Although no specimen undoubtedly referable to this form is included in the collection under examination, a few remarks under this heading may be useful as a preface to the account of an individual, to be described below, which I believe to be very closely related to *H. baini*.

* von Koenen (2), p. 151, Taf. liv., fig. 2.
† Nicklès (1), pl. ix., figs. 3 and 10.
‡ Weerth (1), p. 16, Taf. iv., fig. 4.

Occurrence.—*H. baini* has been found at localities on the Zwartkop's and Sunday's Rivers, and its occurrence in the Zwartkop's River Valley below Uitenhage has been noted by Messrs. Rogers and Schwarz.* Specimens in the collection of the Geological Society (Sharpe's type, registered 10976A) and in the British Museum (registered 52052) are from the Sunday's River.

Remarks.—Neumayr thought *H. baini* to be most closely related to *H. schenki* (Oppel),† from the Spiti Shales of Tibet, and there is indeed a great resemblance between the two in all the more important features; but *H. baini* is more closely ribbed, and as mentioned by Uhlig,‡ in regard to the fineness of the ribbing, *H. schenki* occupies a position just midway between *H. baini* and *H. atherstoni*. Neumayr and Uhlig § also thought close relationship to exist between *H. baini* and *H. keyserlingi* Neum. and Uhl. from the Neocomian of North Germany, but the manner of division of the ribs is really a strong distinguishing feature. In *H. baini* none of the ribs bifurcate after leaving the nodes. The relationship of *H. baini* to *H. diptychus* (Keys.) and *H. polyptychus* (Keys.) || from Petschora-Land is also no doubt much more remote than Neumayr supposed, and these forms, as well as *H. keyserlingi*, clearly do not belong to the same division of the *Holcostephani* (sensu lato) as *H. baini* and *H. schenki*. Nikitin,¶ in fact, has strongly criticised Neumayr's suggestion of relationship between *H. schenki* and these two ammonites from Petschora-Land, and Pavlow has also referred to this matter.**

Remarks on the points of resemblance between *H. baini* and *H. rogersi* sp. nov. will be found appended to the description of the latter given in these pages.

Neumayr †† dealt fully with the question of a suggested resemblance between *H. baini* and a Jurassic ammonite from Madagascar ascribed to J. Sowerby's *Ammonites herveyi*,‡‡ and showed that these really have no significant characters in common. The points of resemblance are in fact so slender as not to merit further discussion here; but it may be remarked that Neumayr probably misrepresented the case when he wrote as follows: "Newton thinks to have found close relationship between *Macrocephalites herveyi* from Madagascar and *Olcostephanus baini* Sharpe from the Uitenhage

* Rogers and Schwarz (1), p. 7.

† Oppel (2), p. 286, Tab. 81, figs. 4*a–c*; Uhlig (4), p. 130, pl. xviii., figs. 2*a–c*.

‡ Uhlig (4), p. 132.

§ Neumayr and Uhlig (1), p. 156.

|| Keyserling (1), p. 327, pls. xx., figs. 4, 5; xxi., figs. 1–3; xxii., figs. 9, 10.

¶ Nikitin (1), p. 122.

** Pavlow and Lamplugh (1), p. 488 (p. 130 of authors' copy).

†† Neumayr (5), p. 6.

‡‡ Newton (1), p. 334.

Formation." In the description of the Madagascar fossils, the opinion that these two forms are truly related was not expressed, and it is not necessary to infer that such a view was actually entertained.

Kilian * has suggested that *H. baini* may represent an immature stage of *H. atherstoni* (Sharpe), but this is certainly not the case. *H. atherstoni* at a comparable growth-stage is much more finely ribbed, to mention only one point of distinction.

With regard to the type-specimen of *Ammonites baini* Sharpe, preserved in the collection of the Geological Society, it is perhaps well to note that in the late Prof. J. F. Blake's published list of the types and figured specimens in the Society's museum, reference is accidentally made to a wrong specimen.† The individual figured by Sharpe was unfortunately overlooked by Mr. C. D. Sherborn when preparing a manuscript catalogue of the collection some years ago. The specimen erroneously noted as the type (registered 10976) was presented by Atherstone and bears the date 1876; ‡ I consider it to represent a hitherto undescribed form, and it is dealt with in these pages under the name *Holcostephanus modderensis.*

Holcostephanus cf. baini (Sharpe).

Plate IX., fig. 2; X., fig. 1.

A single specimen, from the collection in the South African Museum, agrees so closely with Sharpe's *Ammonites baini* that it has seemed questionable whether it should not be considered identical.

Description.—The specimen, which is considerably larger than known examples of *H. baini,* consists of at least four whorls, and the form of these as well as the degree of overlap in the earlier whorls is the same as in *H. baini.* Some of the shell substance is retained and the specimen is partly preserved as a cast, but it exhibits in very imperfect manner the course of the septal sutures, so that these cannot be satisfactorily copied for illustration. The body-chamber is not preserved. In the interior whorls the umbilical wall of each whorl falls upon the umbilical tubercles of the preceding whorl, but in the latter half of the last whorl the degree of involution becomes slightly reduced, so that the nodes of the preceding whorl are completely exposed and the beginnings of the flank ribs proceeding from them can be just discerned. At the same

* Kilian (4), p. 865. † Blake (2), p. 59.

‡ Sharpe's figure of *H. baini* was published in 1856.

time, the slope of the umbilical wall of the last whorl becomes slightly less steep.

There are sixteen strong umbilical marginal tubercles in the last whorl preserved, and from these the ribs of the flank and periphery proceed most frequently in groups of three, though occasionally only two ribs are given off from the nodes. Sometimes a rib may be situated between two nodes at one of its extremities, while springing from a node at its opposite end. These relations of the ribs, however, are the same in *H. baini.* The ribs as they depart from the tubercles to cross over the periphery are not forwardly inclined, but pass almost straight across the whorl. In the most advanced portion of the specimen the crests of the ribs upon the peripheral area are situated at a distance of 6 mm. apart. Well-marked constrictions are present as in *H. baini.*

Dimensions.—

Greatest diameter of specimen	92 mm.
Greatest breadth of last whorl in cross-section	53 ,,
Greatest height of last whorl at the centre (section)	24 ,,
Greatest diameter of the umbilicus, measured from the umbilical rim between the tubercles	45 ,,

Occurrence.—This specimen is believed to come from the Sunday's River.

Remarks.—There can be no douht that the form here represented is very closely related to *H. baini,* and I was for some time undecided whether definitely to identify the two. Allowing for the difference in dimensions between this specimen and the examples of *H. baini* that I have seen, which are smaller, the only apparently valid character of distinction is in the disposition of the ribs. In *H. baini* the ribs proceeding over the whorl from the nodes have a well-marked forward throw, but such an inclination is not seen in the specimen above described. Mr. G. C. Crick, who has kindly examined the specimen, considers that this is a significant point of distinction, but admits that in other respects the two forms are very closely similar. With regard to the inclination of the ribs as a constant and reliable character, it may be remarked that in the British Museum collection a specimen of *H. baini* (registered 52052) which strikingly resembles Sharpe's type in all other points, agrees with it also in showing the same inclination of the ribs. It therefore appears evident that in this character of the ribbing we have a distinctive feature for separation, whatever this alone may be worth. There is unfortunately as yet only a single specimen available for comparison, and since in other respects it shows such close agree-

ment with *H. baini*, I am unable to arrive at a definite opinion as to the nearness of its relationship to that form, and feel hardly justified in proposing a new specific name. It is to be hoped that the acquisition of additional material may enable a more thorough comparison to be made and lead to a clearer knowledge of the actual relationships.

The specimen has much general resemblance to *H. rogersi* sp. nov., but is more coarsely ribbed. In *H. rogersi*, too, the ribbing shows a still greater departure from that of *H. baini*, in that the secondary costæ as they proceed from the tubercles are not truly direct in their course across the periphery, but have a very sli ht backward throw.

Holcostephanus rogersi sp. nov.

Plate IX., fig. 3 ; X., fig. 2.

Description of a Single Specimen.—The shell is involute to the umbilical tubercules, and the ultimate whorl is broad in section and broadly rounded on the peripheral area. The umbilical wall falls very steeply and the umbilical rim is bluntly rounded. The primary ribs, commencing above the spiral suture, are narrow, and rather weakly developed. They have a slight backward slope as they are traced up to the marginal nodes. There are about sixteen of these laterally compressed, not very prominently developed tubercles in the ultimate whorl. From these the ribs of the flank proceed mostly in groups of three, though there are occasionally only two ribs terminating at a node, or a rib-ending may now and then fall between two nodes. These ribs as they pass from the tubercles over the peripheral area are very slightly reclined, that is, have a backward slope in relation to a radius. In the anterior portion of the ultimate whorl the crests of the ribs on the peripheral area are separated from one another by a space of 3 mm.

Two strongly developed constrictions are visible on the ultimate whorl, and they are situated opposite to one another. The specimen is entirely septate, but so preserved that the figure of the lobe-line cannot be traced.

Dimensions.—

Greatest diameter	63 mm.
Greatest breadth of the last whorl in cross-section	40 ,,
Height of the last whorl at the centre, in section	16 ,,
Greatest diameter of the umbilicus, measured from the umbilical rim between the tubercles........................	25 ,,

Occurrence.—The specimen, in the collection of the South African Museum, is from the Sunday's River.

Remarks.—Although I have only seen a single specimen, and the state of preservation of this is not so good as might be desired, I have no hesitation in pronouncing it to represent a hitherto undescribed form. It is apparent that though distinctively characterised, particularly by the feature of reclined costation, this ammonite may be brought into closest relationship with *H. baini* (Sharpe) and *H. schenki* (Oppel), and particularly with the latter. *H. baini* has the whorl relatively narrower and more highly arched in section, while its ribbing is noticeably coarser. On the peripheral part of the whorl at a comparable stage there are seven ribs in *H. rogersi* within a space which includes only six ribs in *H. baini*. Moreover, the ribs in *H. baini* have a marked forward inclination as they depart from the nodes.

Reference to the published descriptions and figures of *H. schenki*,* from Shangra, east of Puling (Tibet), seemed to show a very close resemblance between the two forms, but I have been able to supplement this by an actual comparison with Oppel's type-specimen in the State Palæontological Collection at Munich, and when making this comparison I was fortunate in having the kind assistance of Prof. J. F. Pompeckj. *H. schenki* has rather more numerous umbilical tubercles and is slightly more densely ribbed than *H. rogersi*. In *H. schenki* the umbilicus is relatively a little wider and in cross-section the whorl is rather wider between the umbilical rims, in relation to the height. The most notable point of distinction, however, is in the course taken by the secondary ribs as they pass from the tubercles over the periphery. In *H. schenki* they have a forward inclination, while in *H. rogersi* they are slightly reclined.

There is considerable resemblance between *H. rogersi* and *H. guebhardi* Kilian,† from the Hauterivian of the neighbourhood of Escragnolles in the Maritime Alps, but in *H. guebhardi* the ribbing of the flank is strictly radial in direction.

Holcostephanus modderensis sp. nov

Plate X., figs 3, 3*a*.

1892. *Astieria schenki* A. P. Pavlow (*partim*), Bull. Soc. Imp. Nat. Mosc., année 1891, Nouv. Sér., tome v., p. 493 (p. 135 of authors' copy).

Description of a Single Specimen.—The shell has rapidly expanding whorls, and is involute to the umbilical marginal tubercles in the

* Oppel (2), p. 286, Tab. 81, figs. 4*a*–*c*; Uhlig (4), p. 130, pl. xviii., figs. 2*a*–*c*.

† Kilian (4), p. 866, pl. lvii., figs. 2*a*, 2*b*.

most advanced stage represented in this individual, in which the ultimate whorl is not complete anteriorly. The greatest breadth falls at the umbilical rim, and in section the ultimate whorl is very broad in relation to its height; the peripheral area forms a broadly flattened arch. The umbilical wall falls very steeply and abruptly from the rounded rim, and the relatively narrow umbilicus has the form of a profound and acutely pointed funnel.

The umbilical ribs, commencing above the spiral suture, are narrow, and they are slightly backwardly directed as they pass up into the compressed and fairly prominent marginal tubercles. There are sixteen of these flattened tubercles in the ultimate whorl, and from them the secondary costæ proceed mostly in regular groups of three, though from two of the nodes four ribs are given off. The secondary ribs follow a direct course from the nodes across the periphery except near the anterior part of the whorl, where a few of them appear to have a very slight forward inclination. This, however, may possibly be due to an accident of preservation, and may stand in relation to a slight distortion exhibited by the specimen in its anterior part. The ribs crossing the periphery are fairly prominent, and at the anterior part of the peripheral area the crests of adjacent ribs are situated at 4 mm. apart from one another. On the last whorl there is a single deeply impressed constriction.

In this specimen the shell is in great part preserved, and the course of the septal sutures remains unknown. The ultimate whorl seems to comprise a part at least of the body-chamber.

Dimensions.—

Greatest diameter	80 mm.
Greatest breadth of the last whorl in cross-section	68 ,,
Height of the last whorl at the centre, in section	25 ,,
Greatest diameter of the umbilicus, measured from the umbilical rim between the tubercles	28 ,,

Occurrence.—The specimen is from the Modder Drift, Sunday's River, and is preserved in the collection of the Geological Society of London (registered 10976).

Remarks.—The specimen here described was thought by Pavlow to represent *H. schenki* (Oppel). It bears a label "*Ammonites baini* Sharpe, Jurassic, Modder Drift, S. Africa. Dr. Atherstone, F.G.S., 1876," and the descriptive details given by Pavlow (*op. cit.*, p. 493) apply to it accurately. I am convinced that this African form is so characterised that it cannot rightly be united with *H. schenki*, and though it appears highly probable that the two are

very closely related, I believe that the following points fully justify the separation. In *H. modderensis* the whorl increases more rapidly in breadth and the involution is stronger than in *H. schenki*. The umbilicus is relatively narrower and the umbilical wall falls more steeply in *H. modderensis*, in which also the umbilical ribs, at least in the ultimate whorl, have a definite posterior inclination when traced up towards the tubercles. In cross-section, the whorl is considerably broader in proportion to height than in *H. schenki*. Further, not only is the ribbing of *H. modderensis* at a comparable stage somewhat coarser, but the costæ as they pass from the tubercules across the periphery mostly follow a straight course, while in *H. schenki* they have a well-marked forward inclination.

It is scarcely necessary to make a detailed comparison between *H. modderensis* and *H. rogersi*, described above. *H. modderensis* is a much more inflated and globose shell, and the rate at which the whorls increase in breadth is considerably more rapid ; the umbilicus is also relatively narrower, and the breadth of the whorl-section proportionately greater than in *H. rogersi*.

H. baini (Sharpe) * is no doubt a related shell, but *H. modderensis* is well distinguished from this by its inflated form, the great breadth and diminished height of the whorl-section, the rapid increase in breadth of the whorl, the narrower umbilicus, and the direct course of the secondary ribs as they cross the periphery. *H. modderensis* is also considerably more densely ribbed than *H. baini*.

One of the forms figured by Pictet as *Ammonites bidichotomus* Leym.,† which Pavlow considered identical with Oppel's *H. schenki*, appears to be well distinguished from *H. schenki* by the coarser ribbing, the direct course of the secondary ribs, and the absence of noticeable constrictions. As far as it is possible to make comparison by means of Pictet's figures, the Swiss shell seems to approach more closely to *H. modderensis*, though at the stage represented it is less strongly involute. A satisfactory comparison between this figure of a small specimen and the relatively large specimen of *H. modderensis* is, however, not possible.

A specimen from Neuchatel figured by Pictet as *Ammonites astierianus* d'Orb.‡ was united with *Ammonites spitiensis* Blanford by

* Sharpe (1), p. 197, pl. xxiii., fig 2.

† Pictet and Campiche (1), pl. xli., fig. 3 (1860).

‡ Pictet and Campiche (1), pl. xliii., fig. 2 (1860).

Pavlow,* but a reference to Uhlig's † description and figures of *Holcostephanus spitiensis* shows this to have been an error. Pictet's figure represents an inflated form which has some resemblance to *H. modderensis*, but it differs from this by its relatively higher whorl-section, less strong involution, and greater number of umbilical ribs. Here again, the comparison cannot be quite satisfactorily made, because Pictet's figure is drawn in half the natural size, and the original specimen would have attained a stage when its dimensions were almost twice those of the individual of *H. modderensis* compared.

It is also difficult to make comparison with the small inflated specimens from Berrias (Ardèche) figured by Pictet under the name *Ammonites astierianus*.‡ These might conceivably represent an earlier stage in the growth of such a form as *H. modderensis*, but if this be the case some changes in the degree of involution and in the form of the whorl-section would have to follow. While of apparently very similar type to *H. modderensis*, at the stage represented in Pictet's figure the involution is less strong and the whorl more highly arched in section, and relatively narrower. Pictet's "Varieté No. 3," from the same place,§ while possessing a broad and depressed whorl-section, is still more strongly distinguished from *H. modderensis* by the much wider umbilicus and the diminished involution. The specimens represented in Pictet's plate 17, figs. 3 and 4, were considered by Pavlow to be *Holcostephanus spitiensis* (Blanf.), but I believe this view to be erroneous. They seem to me to illustrate a form probably more aptly comparable with *H. modderensis* than with either *H. spitiensis* or the true *H. astierianus* with which they were at first identified.

An ammonite from the Tithonian of Stramberg, figured by Zittel‖ under the name *Ammonites grotianus* Opp., and thought by Pavlow to represent *Holcostephanus spitiensis* (Blanf.), is believed by Uhlig¶ to be distinct from both of these and to stand nearer to the true "*Astieriæ*." It has a whorl-section and inflated form somewhat resembling that of *H. modderensis*, but it is a more widely umbilicate shell, and at the stage of growth represented in Zittel's figure there is a marked difference in the relation of the secondary ribs to the umbilical tubercles.

* Pavlow and Lamplugh (1), p. 497 (p. 139 of authors' copy).

† Uhlig (4), p. 89, pl viii., figs. 1–3.

‡ Pictet (1), p. 86, pl. 17, figs. 3, 4.

§ Pictet (1), p. 86, pl. 18, fig. 3.

‖ Zittel (3), p. 90, pl. 16, figs. 3, 4.

¶ Uhlig (4), p. 94.

Holcostephanus uitenhagensis sp. nov.

Plate XI.

1905. *Olcostephanus bainii* F. H. Hatch and G. S. Corstorphine (*partim*). The Geology of South Africa, p. 243, fig. 65 (right-hand specimen only).

Description of a Single Specimen.—The specimen is preserved chiefly in the form of a cast which in the greatest portion of the ultimate whorl has retained, though somewhat imperfectly, the impress of the external costate ornaments. The specimen is also slightly distorted by pressure.

The shell has a laterally compressed aspect, and the whorls are relatively narrow and highly arched in section. The flanks are broad and flattened in form, while the peripheral area presents a somewhat narrowly convex surface. The involution is such that about two-thirds of the flank of the preceding whorl are embraced, thus leaving a considerable space free between the spiral suture and the umbilical margin of the preceding whorl. The greatest breadth of the whorl is at the umbilical margin, though the breadth at the middle of the flank is little less than this until the anterior portion of the ultimate whorl is reached, when the whorl is relatively rather more inflated.

The umbilical margin is abrupt, and the umbilical wall falls almost vertically until traced to the last half of the ultimate whorl, where the wall slopes with slightly decreasing steepness. Umbilical ribs are not developed in the last whorl. The umbilical marginal tubercles, present to the number of fifteen in the last whorl, are not strongly compressed in form, and they are well spaced. The ribbing of the shell is relatively fine, and in the ultimate whorl three or four costæ proceed from each tubercle, in addition to which there are some costæ which terminate between the tubercles and occasionally a rib may become intercalated on the flank. There is no evidence that any bifurcation of the costæ occurs on the flank. The ribs as they pass towards the periphery are forwardly inclined, more noticeably so in the anterior half of the ultimate whorl, where, on the peripheral area, adjacent ribs have their crests 6 mm. apart. The development of constrictions is very weak and inconspicuous.

Dimensions.—

Greatest diameter	22	cm.
Greatest breadth of the last whorl in cross-section	9	,,
Height of the last whorl at the centre, in section	6	,,
Greatest diameter of the umbilicus, measured from the umbilical rim between the tubercles	7·5	,,

Occurrence.—In clay between two hard calcareous bands in the railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the Graaff-Reinet railway, about three miles from Uitenhage (276).

Remarks.—The specimen here described was referred to by Messrs. Rogers and Schwarz * as "an *Olcostephanus* . . . allied to *O. atherstoni*," and it was rightly stated to be distinguished from this by "being more compressed laterally, in having no umbilical ribs, and in the less overlapping of the whorls." *H. uitenhagensis* is considerably more discoidal in form, and the rate of increase in the breadth of the whorl-section is much less than in *H. atherstoni* ; the umbilicus is also very much wider and relatively shallower than in Sharpe's type. The ribbing of these two forms is of closely similar character, and both agree also in the very inconspicuous development of constrictions.

In the lateral compression of the shell and the fine character of the ribbing, the wide umbilicus and the degree of involution, *H. uitenhagensis* is more reminiscent of the typical *H. astierianus* (d'Orb.) † than of some of the more coarsely ribbed and inflated *Holcostephani* that occur in the Uitenhage Series ; but the points of distinction are so marked that a detailed comparison with *H. astierianus* is unnecessary. The same remarks apply when we attempt a comparison between *H. uitenhagensis* and *H. sayni* Kilian,‡ the finely ribbed form which was originally thought to be identical with *H. astierianus*. In general habit there is similarity to the finely ribbed *H. filosa* (Baumberger)§ from the Hauterivian of the Swiss Jura, but the two forms are far from being identical.

Genus ACANTHODISCUS V. Uhlig.

Acanthodiscus sp.

Description of a Single Specimen.—The specimen consists of a fragment of the chambered part of a large whorl. It measures about 70 mm. from end to end along the periphery, and the cross-section at the anterior end is 35 mm. in height and about the same in breadth. The specimen is considerably weathered, and has had the shell partially removed, showing here and there a portion of the lobe-line and displaying the siphuncle near the posterior end. The whorl is slightly flattened on the sides and evenly and broadly

* Rogers and Schwarz (1), p. 10.

† d'Orbigny (1), pl. 28, fig. 1 (1840).

‡ Kilian and Leenhardt (1), p. 976 ; Sarasin and Schöndelmayer (1), part 1, p. 38, pl. iv., figs. 2, 3.

§ Baumberger (1), 4er Theil, p. 31, pl. xxiii., figs. 2*a*, 2*b*.

arched in the peripheral area. To judge by the channelling of the inner surface, the involution was relatively slight. Since the height of the cross-section at the posterior end is slightly over 30 mm., the rate of increase of the whorl was not rapid.

The umbilicus must have been shallow. The umbilical rim is not abruptly defined, though the surface of the flank slopes down steeply to the spiral suture. Primary ribs starting from the suture are radial in direction and are not of equal strength. At the rounded umbilical margin, some of the ribs (main ribs) swell into a rounded node, and a bifurcation of the rib may here take place, giving rise to ribs of unequal strength. Some ribs, however (intermediate ribs), do not bear umbilical nodes, and bifurcation at the nodes on the main ribs does not always take place. Some of the ribs arising from the umbilical nodes have a forward inclination as they pass towards the periphery. On the peripheral side of the middle of the flank, but near the middle, a second set of nodes is developed on the main ribs, stronger than the inner series. At these nodes a division of a rib into two or three peripheral ribs takes place, and these have a well-marked forward inclination. The intermediate ribs have a corresponding forward swing as they pass on to the periphery. The peripheral ribs are of approximately equal strength and pass across the periphery, though their development is less pronounced in the central area. This area is flat, and in better preservation might be weakly sulcate. On either side of it the ribs show traces of a swelling.

The inner surface of the fragment (that is, the concave surface) is deeply channelled, in such manner as to show that the previous whorl had a distinctly sulcate periphery, and that the central concave area was bounded on either side by a line of nodular swellings in the peripheral ribs.

Occurrence.—Collected at Brentford, Knysna Estuary (151h).

Remarks.—It is unfortunate that only a single fragment of this well-characterised form is available for study. The specimen is so imperfect that its intimate relationships cannot be precisely ascertained, and the important evidence of young and early adult growth-stages is wanting. There can scarcely be a doubt, however, that we are dealing with a representative of that group within *Hoplites* (sensu lato) to which Uhlig has given the generic name *Acanthodiscus*.* Whether this group of trituberculate forms constitutes a generic unit may be open to question, in view of the differences in the characters of the youthful stages shown by some of its members, though

* Uhlig (5), p. 607.

Professor Uhlig has suggested that the occurrence of cœnogenetic phenomena may account for these. So far as the characters of sculpture of this fragment are concerned, a very similar type is seen in the adult stage of *Acanthodiscus hystricoides* (Uhlig),* from the upper Teschener Schichten of Silesia (correlated by Uhlig with the Valanginian). To judge from a comparison of such scanty material with the figures of *A. hystricoides*, the African specimen differs in the more nearly circular section of the whorl, in the occurrence of groups of three peripheral ribs arising from the outer tubercles of the flank, and perhaps also in the greater number of ribs intermediate between the main ribs. It also shows a more strong forward inclination of the ribs as they pass from the flank to the periphery.

It is impossible to say with certainty whether this form bears any close relationship to Tate's *Ammonites subanceps*, which also came from the Uitenhage beds. Tate's figured specimen † is the only one of its kind known from these beds, and it is a small individual, representing in all probability an immature stage of growth. This probability, and the great disparity in size between Tate's type and the fragment of an adult *Acanthodiscus* above described, makes a comparison difficult and unsatisfactory. The fragment here dealt with formed part of an individual exceeding 110 mm. in diameter, with an umbilical diameter, measured from the inner tubercles, of probably 45 mm. Tate's specimen measures less than 20 mm. in greatest diameter. Allowing for this, however, there is some similarity in the type of sculpture in the two forms. If they are closely related the points of distinction that exist may well be due to the fact that different stages of growth are brought into comparison. In the specimen from Knysna the sulcation of the peripheral area is very weakly marked, but it is seen from a comparison of the outer and inner sides of the whorl that this is a modification accompanying advancing growth, and that the previous whorl was much more sulcate. It is also probable that the reduction of this character is to some extent only apparent, owing to the removal of the shell-substance on the outer side by weathering. Other points in which the specimen differs from Tate's type are the presence of well-marked nodes at the umbilical margin, the situation of the second series of nodes a little nearer to the periphery, the stronger forward inclination of the peripheral ribs, and the rather broader periphery and more nearly circular outline of the whorl in cross-

* Uhlig (2), p. 39, Taf. i., fig. 8.
† Tate (1), p. 150, pl. vii., fig. 3.

section. It should be noted with regard to the first of these points that although Tate made no mention of any trace of umbilical marginal tubercles in his specimen, such traces exist in several of the ribs, which are swollen at that part which corresponds with the row of umbilical nodes in the Knysna specimen.

While bearing in mind that these forms are so far comparable, it is at the same time not improbable that Tate's *Ammonites subanceps* should be placed with those species of *Hoplites* (sensu lato) which Uhligh as united to form the narrower generic group *Solgeria.** Great similarity is shown to figures of forms ascribed by Sayn † to *Hoplites arnoldi* (Pict. and Camp.) and by Toucas to *Hoplites botellæ* Kilian.‡ These have been considered by Pavlow to be wrongly determined, and to represent one species to which he has given the name *Hoplites heteroptychus.*§ It was even suggested by Neumayr that *Ammonites subanceps* might represent the young of *Crioceras spinosissimum*, and this does not seem excluded as a possibility. While Tate's specimen, which was very imperfectly figured, is certainly to be brought into the closest comparison with Neocomian forms of *Hoplites*, and not with the Jurassic *Reineckia anceps* as thought by Tate, only the collection of additional material will show with certainty its true narrow relationships, though I am inclined to think that its nearest allies are to be sought in representatives of Uhlig's genus *Solgeria*, of which *Hoplites heteroptychus* Pavlow is an example, rather than in members of the genus *Acanthodiscus.*

Genus BELEMNITES Lamarck.

Belemnites sp.

Two specimens of belemnites are unfortunately only of a fragmentary character. One was collected by Mr. Rogers at Brentford, Knysna Estuary (153h), and the other was obtained by Miss M. Wilman at Coega.

1. The specimen from Brentford is a fragment of a rostrum, and neither the alveolar nor apical end is preserved. It is compressed in the dorso-ventral direction in such manner as to give a broadly ovate outline in cross-section. The greatest transverse diameter is situated at some distance—at least a third of the length of the fragment—away from the alveolar end of the specimen. From this

* Uhlig (5), p. 624.

† Sayn (1), p. 682, pl. xii., fig. 6.

‡ Toucas (1), p. 606, pl. xviii., fig. 10.

§ Pavlow and Lamplugh (1), p. 467 (109 of authors' copy).

point the outline tapers very gently, almost imperceptibly, in the alveolar direction, more markedly (though still gradually) in the apical direction. The length of the fragment is 45 mm. At the end towards the alveolus the transverse diameter is 11 mm., the dorso-ventral diameter 9·5 mm. At the other end the transverse diameter is 9 mm., the dorso-ventral measurement 8 mm. Situated on the side are two parallel, shallow longitudinal grooves, placed closely to one another. Towards the anterior end of the specimen the surface is becoming split off in the form of thin laminæ.

This specimen is evidently the representative of some subfusiform species. The shape of the rostrum, though this is represented by an imperfect fragment, is sufficiently suggestive, and in addition there is the presence of the shallow parallel grooves on the side and the foliaceous character of the surface towards the alveolus. These two latter points, apart from the shape of the guard, at once recall certain Hastati of the European Neocomian, and there can be no doubt concerning the broad relationships of the specimen. The greatest thickness of the guard is, however, nearer to the alveolus than in *Belemnites jaculum* Phill. (=*B. subfusiformis* Rasp.), *B. pistilliformis* Blainv. (=*B. pistillirostris* Pav.), or *B. obtusirostris*.* The outline in section is more oval and compressed than in *B. jaculum*, and although in that species there is some variation with regard to the form of the section, Mr. G. W. Lamplugh informs me that he has never observed quite such a degree of compression as is shown by the Brentford specimen.

2. The specimen from Coega is still less favourably preserved for a satisfactory comparison with known forms, but it also belongs to some subfusiform species, and one which has a rostrum of relatively slender figure. It is a fragment of a guard from which the alveolar and apical ends are missing, and is compressed in manner similar to that shown by the other specimen. It measures 46 mm. in length. The transverse diameter at the thicker end is 8 mm., the dorso-ventral diameter 7 mm. The specimen tapers gradually from here towards the thin end, where the greatest diameter is 4 mm. This end is most probably approaching the alveolus, though it shows no sign of a ventral groove. Here also the surface shows no foliaceous character, but the specimen is so unfavourably preserved and so much weathered that these negative characters are not of much significance. It is possible, however, that this thin end of the specimen lies towards the apex, but if this be the case we are dealing with a hastate form remarkable for the slow tapering towards the

* Pavlow and Lamplugh (1), pp. 77–82.

apex. I am inclined to regard the other orientation as the correct one.

These two specimens, although so fragmentary, are of special interest. They furnish one more piece of evidence which serves to dispel the idea that the fauna of the Uitenhage beds lived under geographical conditions which prohibited free intercourse in a northerly direction. It will be remembered that a representative of the Hastati has been recorded from the Neocomian beds of north-west Madagascar.* An extension of our knowledge of the belemnite-fauna in the Uitenhage deposits becomes very desirable.

Class CRUSTACEA.

Genus MEYERIA F. M'Coy.

Meyeria schwarzi sp. nov.

Plate VIII., fig. 22; IX., 4, 4*a*, 5; X., 4, 4*a*, 4*b*.

Description.—The elongated body shows, in its form, considerable lateral compression, and the carapace, in particular, has strong lateral flattening. The carapace, in lateral aspect, has relatively great height, and the branchiostegites occupy a large area. The cephalic portion of the carapace is best known in its posterior part, since the best-preserved specimens examined have the anterior part broken off. Commencing at the cervical suture and passing forwards there is a sharp and narrow, weakly serrated, median dorsal keel which is prolonged anteriorly into a short, sharply pointed, laterally flattened rostrum, exhibiting a median carination, weakly and finely serrated. Running almost parallel with this median keel and at a very short distance below it there is on either side a more strongly tuberculated or serrated lateral keel; at a rather greater distance below this on either side there is situated a second similar lateral keel, and, with a still greater separating space, below this there is a third lateral keel. The two lowest keels on each side have a more marked upward slope than the first lateral keel when traced forwards from the cervical groove. The surface between the keels is flat or slightly concave, and bears very little or no granular ornamentation. The appendages of the head are unknown.

The cervical suture slopes backward rather obliquely in its general course when traced upwards. In relation to the slenderly formed

* Newton (1), p. 333.

carapace it is deeply impressed. Traced from its anterior termination, for the first few millimetres of its course, immediately under the lowest cephalic keel, it has a very slight upward inclination; it then bends more sharply upwards, and during the rest of its course, towards the median dorsal line of the carapace, it is not markedly sinuous.

Immediately behind the cervical suture there is on either side a short raised keel in backward continuation of the lowest lateral cephalic keel; this is only a few millimetres in extent (about 5 mm. in specimens examined), and immediately below it is situated a small oval area, nearly smooth, bearing only one or two isolated granules, and surrounded above and below and behind by a well-impressed linear groove. In the specimens examined this is only about 2 mm. or 3 mm. in length, but is not well defined anteriorly. From this little area the weakly developed branchial furrow passes obliquely backwards, rising gradually, and dies out before reaching the indented portion of the posterior margin of the carapace. This furrow is bounded dorsally by a slightly raised fold of the surface, which arises anteriorly at the short keel which forms the backward continuation of the lowest cephalic keel.

The median dorsal carination is a very marked feature, posteriorly to the cervical groove. Commencing at the median carina at a distance from the cervical suture of about one-third of the space between that suture and the posterior margin of the carapace, there is a very faintly marked, shallow linear groove of attenuated sigmoidal form. Meeting the corresponding groove of the opposite side in the median dorsal line so that no appreciable angle is formed by the junction, the groove on each side of the carapace forms a shorter shallow upper curve and a more extensive lower curve. Before terminating below it is for some distance directed anteriorly, and runs obliquely downwards just above the fold of the surface which accompanies the branchial furrow.

The lower margin of the thoracic part of the carapace is divisible into a shorter antero-ventral portion, which slopes gently downwards with straight outline when traced backwards, and a longer posterior portion with almost straight outline, which slopes gently upwards and then passes by a broad curve into the posterior border. The posterior border forms in its lower part a broad lobe with convex outline, and is then indented (between the branchial and cardiac regions) in the shape of a narrowly curved bay with broad opening.

The margins of the thoracic portion of the carapace are furnished

with a smooth, narrow, raised lip, which becomes somewhat broader on the posterior lobed margin of the branchiostegite, where, also, it is accompanied by a smooth, hollowed, shallow runnel of the surface. The branchiostegites are ornamented by numerous granules or minute tubercles distributed evenly over their surface. The raised folds of the surface which are situated just dorsally to the oblique branchial furrows are furnished with a row of somewhat stronger granules, besides a few granules irregularly disposed. The region of the carapace situated between the weak sigmoidal grooves (above described) and the cervical suture is ornamented by numerous granules or minute tubercles similar to those on the branchiostegite. The cardiac region, posteriorly to this, is more nearly smooth, showing only a few isolated, weakly developed granules.

The ambulatory appendages of the thoracic region are known only by a few fragments, and those actually associated with carapaces are too imperfect for accurate description. Portions of a long, slender limb occurring isolated in a nodule from the Sunday's River (the specimen is from the South African Museum collection, and bears the number 663 on a white label) may probably belong to this species. It consists of a portion of a segment of the limb, keeled, with some scattered granular ornaments and bearing a short, distally directed, lateral pointed spur, near the articulation with the succeeding (more terminal) segment. The latter is very slender and elongated and bears several longitudinal tuberculated keels.

The terga of the first five abdominal segments have a smooth surface and are narrowly and highly arched. The pleura of segments ii.–v. have a flattened or slightly convex form ; they are relatively extensive and bear ornaments. The tergum of the first segment is divided across the middle by a well-marked transverse (right and left) groove. The posterior part only of this tergum is prolonged downwards to form a very small pleuron with rounded margin anteriorly, and broadly pointed below. This bears pitted ornamentation and has a transverse carination, the carinal ridge extending forwards from the point of articulation with the tubercular facet of the second segment. The surface of the pleuron below the short carina is set at a slight angle to the part above, and is flattened for movement against the posterior lobe of the branchiostegite.

The second abdominal segment is relatively broad (antero-posterior measurement), and has very large pleura which bulge forward just below the tubercular articulating facets, and have very extensive

antero-ventral margins which form a broadly convex outline. Their truncated posterior borders are slightly sinuous—being projected backwardly just below the articular socket, and having a slightly excavated outline below this. The posterior borders bear minute marginal denticles, and they form a roughly rectangular junction, below, with the antero-ventral border. There is a shallow vertical groove on the surface near the posterior border, and the pleuron also bears granular and pitted ornaments on its upper and posterior parts. Posteriorly situated, on its lower half, are two short, parallel, raised ridges bearing several minute tubercles: these have a transverse (horizontal) direction, and the lower is the shorter of the two. On the pleura of the succeeding three segments (iii.–v.) the ornaments are similar, but the horizontal tubercular ridges become reduced in size, particularly in the fifth segment. The pleura of these segments are much less extensive than those of the second segment. Those of the third and fourth segments are pointed below, with sloping, slightly convex, antero-ventral borders, with narrow smooth raised marginal lip and straight posterior borders furnished with a row of minute denticles. The pleura of the fifth segment are more broadly rounded below. Those of the sixth segment are very reduced in extent and have the posterior half of their inferior margin broadly excavated to allow of the free movement of the expanded swimming appendages of this segment. The pleura and tergum of this segment are alike ornamented with minute tubercles.

The tergum of the first abdominal segment has a shallow groove rising from the articular sockets and curving slightly forwards as it crosses the back. Similar grooves occur on the succeeding four segments, two on either side of each tergum. They arise at the (anterior) articular facet and the (posterior) articular socket and slightly converge as they pass up towards the dorsal arch of the tergum. The anterior groove on the second segment may be traced across the back, but the remaining grooves become very faintly marked or disappear on the dorsal parts. On the sixth segment, the corresponding anterior groove is very strongly marked, and passing right across the back, defines an anterior, convex, lenticular shaped tergal facet which fits under the posterior part of the fifth tergum. There is also on either side, in the posterior half of the segment, a horizontal groove, separating the pleuron from the tergum, and these pass posteriorly into a very weak shallow groove which runs across the tergal arch close to the posterior border of the segment.

The telson is relatively narrow and elongated. Its sides form

approximately straight outlines in the anterior half and converge very gradually at first, but more rapidly in the vicinity of the narrowed, rounded, posterior margin. The anterior margin is almost straightly transverse, and forms roughly rectangular junctions with the sides. The dorsal surface of the telson is of flattened form, curving down abruptly at the lateral margins. There is a weak median longitudinal ridge which dwindles away posteriorly before reaching the hinder border. At a distance of about one-quarter of the total length of the telson from its anterior border there arises from the median ridge on either side a curved, narrow ridge, bearing granules or minute tubercles. These first pass backwards, and, diverging from the median ridge, they curve outwards and pass obliquely forwards to the antero-lateral angles of the telson. Each encloses a roughly ovate area of the dorsal surface which is almost smooth, or has very sparse granular ornaments. The remainder of the surface of the telson has evenly spaced granules or minutely tubercular ornamentation.

The appendages of the abdominal segments are unknown, except portions of the expanded swimming organs of the sixth segment; but these are too imperfectly preserved for precise description.

Dimensions.—The largest specimen examined measures 38 mm. along the median dorsal line from the tip of the rostrum to the posterior end of the carapace. The greatest height of the carapace in this specimen, if it were perfect, would be about 16 mm. Other individuals, in which the rostral region is absent, have a similar height-measurement, and the total breadth of their carapaces measured in cross-section does not appear to exceed 8 mm., although the specimens have not suffered appreciably from lateral crushing. The length of the abdomen in extension cannot be accurately measured owing to the flexion assumed at death, but it may be estimated to have been approximately the same as that of the carapace.

Occurrence.—Several specimens were obtained by Mr. Rogers from a bare slope W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop (35h, 37h, 38h).

A specimen consisting of portions of a thoracic limb which may belong to this species is from the collection of the South African Museum and is labelled "Sunday River" (663, on white label).

Remarks.—Since the term "epimeron" has been used in two distinct senses by different authors, the term "pleuron" has been retained in the above description to denote the downward lateral prolongation of the tergum of each abdominal segment on either

side. The usual condition of the abdomen is one of flexion, with the pleura overlapping one another in a marked degree; but one of the specimens examined (38h) shows segments iii.–vi. so extended that the form of the pleura is well exhibited. It will be noted that the conventional terminology here used in reference to the main divisions of the body is that which is most widely known and employed.

The transverse grooves on the terga of the abdominal segments mark the degree of overlap of the segments when these are in the position of extension. The grooves probably correspond with strengthening ridges on the interior surface of the terga which pass upwards from the ball (anterior) and socket (posterior), respectively, of the lateral articulations in each segment. The depth and the dorsal continuity of the anterior groove in the sixth segment, and the smooth, convex, well-developed rolling facet anteriorly to it, which fits closely under the hinder part of the fifth tergum, appear to be contrivances for securing the rigidity and strength called for in the exercise of rapid and vigorous movements of the tail in swimming or springing. The tergal facets of the preceding segments are much less well developed and defined.

Meyeria schwarzi differs widely from *M. ornata* (Phill.),* from the Speeton Clay, in the absence of the characteristic ornaments on the abdominal terga and in the form of the pleura, as well as in other features. From *M. magna* M'Coy [= *M. vectensis* Bell],† of the Aptian of the Isle of Wight, it is readily separable by the absence of ornamenting granular ridges on the abdominal terga, by the weaker development and different position of the oblique branchial fold or carina, and by the form of the pleura. *M. magna* also appears to be a much larger and more robustly formed species. It may be remarked that the fragment of an elongated ambulatory leg (South African Museum collection, No. 663), mentioned above, bears much resemblance, in its relative proportions and in its tuberculated ornamenting keels, to the long and slender anterior thoracic legs of *M. magna*.‡

There appears to be very considerable resemblance between *M. schwarzi* and *M. rapax* Harbort,§ from the Lower Valanginian of North Germany. Both have a smooth surface in the abdominal terga i.–v., and the form and ornamentation of the pleura are very

* Bell (1), p. 33, pl. ix., figs. 9–11.

† M'Coy (1), p. 334; Bell (1), p. 33, pl. x.

‡ Bell (1), pl. x., figs. 1, 4.

§ Harbort (1), p. 11, Taf. i., fig. 12; ii., figs. 1–4; iii., figs. 1, 2; xi., figs. 1, 2.

similar. *M. rapax*, however, attained much larger dimensions and more robust form than any of the specimens of *M. schwarzi* examined, and it appears also from Dr. Harbort's figures that the cephalothorax of his species has less relative lateral compression. Other differences that may be noticed are as follows. In *M. rapax* the development of the obliquely running blunt branchial keel is much more pronounced; the anterior margins of the abdominal pleura are denticulated; the sixth abdominal segment has greater lateral depth and is not so depressed dorsally as the corresponding segment in *M. schwarzi*. Further, Dr. Harbort makes no mention of distinctive ornaments on the telson such as those which characterise the African form. The little smooth oval area at the anterior end of the branchial groove, which is well marked in *M. schwarzi*, does not appear to be an evident feature in *M. rapax*, if developed at all, and the same may be said of the grooves of attenuated sigmoidal form in front of the cardiac region of the carapace.

With reference to the above-mentioned small, smooth, oval area, which is situated on either side of the carapace on the anterior part of the branchiostegite, this structure is well represented also in *Meyeria magna* M'Coy, but does not seem to have attracted special attention. Its significance is not obvious, but it appears to be homologous with the similar areas on the carapace of *Pseudoglyphæa*. These were considered by Oppel to be a constant characteristic of that genus,* and he referred to them as "reniform eminences," but did not enter into the question of their meaning. Corresponding structures of modified form may also be seen in some species of *Glyphæa*.

(A). *LISTS OF THE FOSSILS CRITICALLY EXAMINED.*

The lists of fossils collected by Messrs. Rogers and Schwarz in 1900 and by Mr. Rogers in 1905 should be read in connection with the published official reports by these authors, which contain the records of additional forms seen by the Surveyors to occur at some of the localities. Thus, for instance, in the first report, among the fossils stated to have been found in the Marine Beds at Grass Ridge, near Uitenhage, there are the names of ten Mollusca, specimens of which were not brought away.† In the later report by Mr. Rogers, many fossils are in like manner recorded, which are not represented in the collections submitted for examination.‡

* Oppel (1), p. 51. † Rogers and Schwarz (1), p. 9. ‡ Rogers (2).

(1) Zwartkop's River.

(*Specimens collected by Messrs. Rogers and Schwarz*, 1900.)

a. Railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the railway from Uitenhage to Graaff-Reinet, about 3 miles from Uitenhage.

Thamnastræa sp.	(345, 346, 347, 348, 349)
Serpula cf. *concava* (J. Sow.)	(332)
Pecten (*Camptonectes*) *projectus* Tate	(297, 350)
Lima (*Acesta*) *obliquissima* Tate	(346)
Exogyra imbricata Krauss	(312)
Trigonia conocardiiformis (Krauss)	(297, 298)
,, *vau ?* Sharpe	(309)
Cyprina borcherdsi Tate	(313)
Thetironia papyracea (Sharpe)	(315)
Meretrix uitenhagensis sp. nov.	(316)
Thracia sp.	(331)
Natica uitenhagensis ? sp. nov.	(314, 350)
Holcostephanus uitenhagensis sp. nov.	(276)

b. Grass Ridge, 3 miles east-north-east of Uitenhage.

Trigonia tatei Neumayr	(335)
Trapezium ? tatei sp. nov.	(310)
Meretrix uitenhagensis sp. nov.	(310)
Solecurtus sp.	(310)
Pleuromya baini (Sharpe)	(317, 318, 334, 335)
Actæonina atherstoni (Sharpe)	(333)

c. Krantz near Picnic Bush, north-east of Red House.

Astarte (*Eriphyla*) *herzogi* (Goldf.)	(328)

d. Kloof on the left side of Zwartkop's River, east-north-east of Red House.

Trigonia ventricosa (Krauss)	(308)
Astarte (*Eriphyla*) *herzogi* (Goldf.)	(326, 327)
Tancredia schwarzi sp. nov.	(324)
Meretrix uitenhagensis sp. nov.	(324)

e. Road below railway cutting, 1 mile from Rawson Bridge on the main line, up side.

Bochianites glaber sp. nov. .... (277, 338)

f. Clay-pit on the left bank of Zwartkop's River near Rawson Bridge.

Actæonina atherstoni (Sharpe) .... (343)
Bochianites ? .... (278, 339, 344)

g. One mile north-east of Rawson Bridge.

Modiola baini Sharpe .... (281)

(2) Bezuidenhout's River.

(*Collected by Messrs. Rogers and Schwarz*, 1900.)

Unio uitenhagensis sp. nov. .... (322, 323)

(3) Sunday's River.

(*Collected by Messrs. Rogers and Schwarz*, 1900.)

a. Cliff below the old school-house on the right bank of Sunday's River, Dunbrodie (Geelhoutboom).

Pecten (*Camptonectes*) *cottaldinus* d'Orb. (305, 306)
Perna atherstoni Sharpe .... (305)
Ostrea sp.. (305, 306, 336)
Mytilus uitenhagensis sp. nov. .... (319)
Cyprina rugulosa Sharpe .... (325)
Psammobia atherstoni Sharpe .... (321)
Gastrochæna dominicalis Sharpe .... (336)
Turbo atherstoni Sharpe .... (351)
,, *rogersi* sp. nov. .... (282)
,, *minutulus* sp. nov. .... (305, 351)
,, *sp*. .... (351)
Actæonina atherstoni (Sharpe) .... (283, 284)

b. Walton's Farm, below Dunbrodie.

Perna atherstoni Sharpe....................................... (311)
Trigonia stowi ? sp. nov. .... (307)

(*Collected by Mr. A. W. Rogers*, 1905.)

c. Cliff on Buck Kraal.

Serpula pinchiniana Tate	(122h)
Trigonia herzogi (Goldf.)..................	(116h, 120h, 122h)
Cyprina rugulosa Sharpe	(128h)
Mactra ? dubia sp. nov.	(141h)
Natica ? mirifica sp. nov.	(137h)
Natica rogersi sp. nov......................	(136h)
Limnæa remota sp. nov.	(138h)

d. Cliff on the right bank of Sunday's River on Commando Kraal.

Trigonia conocardiiformis (Krauss)...................... (104h)

e. 300 yards below Addo Drift (Tunbridge's), left bank of Sunday's River.

Trigonia vau Sharpe...................... (40h, 41h, 42h, 46h)

f. Cliff on Zoet Geneugd.

Trigonia conocardiiformis (Krauss)	(67h), from higher beds.
,, *herzogi* (Goldf.)	(99h).
Mytilus uitenhagensis sp. nov.	(64h), from lowest beds.

g. Kloof S. 5 W. from Comley's House, right bank of Sunday's River.

Thetironia oblonga sp. nov. .... (83h)

h. Nek S. 32 E. from Comley's House, right bank of Sunday's River.

Trigonia conocardiiformis (Krauss) .... (86h)

i. Cliff W. 20 S. from Comley's House.

Trigonia stowi sp. nov.	(90h)
Tancredia schwarzi sp. nov.	(95h)
Turbo atherstoni Sharpe....................................	(95h)
Natica ? mirifica sp. nov.	(95h)
Actæonina atherstoni (Sharpe)	(92h)
,, cf. *atherstoni* (Sharpe)	(95h)

j. Bare slope W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop.

Trigonia conocardiiformis (Krauss)	(21h)
,, *rogersi* sp. nov.	(20h)
Astarte sp.	(24h)
Anthonya lineata sp. nov.	(35h)
Meretrix uitenhagensis sp. nov. ...	(24h, 26h, 28h, 29h, 30h)
Actæonina atherstoni (Sharpe) ...	(24h)
Meyeria schwarzi sp. nov.	(35h, 37h, 38h)

k. Kloof behind Colchester.

Meretrix uitenhagensis sp. nov.	(493g, 498g)	from highest beds.
Pleuromya baini (Sharpe) ...	(495g)	,, ,,
Goniomya sp.	(489g)	,, ,,
Actæonina atherstoni (Sharpe)	(499g)	,, ,,
Phylloceras rogersi sp. nov. ...	(3h)	from middle beds.

l. Small kloof 3 miles up the left bank of Sunday's River.

Trigonia stowi sp. nov.	(17h)
,, *ventricosa* (Krauss)	(14h, 15h)

The following list is based upon specimens, in the collection of the South African Museum, from Sunday's River :—

Serpula pinchiniana Tate	(303)
Pecten (*Syncyclonema*) *orbicularis* J. Sow.	(279, 280)
,, (*Chlamys*) cf. *subacutus* Lam.	(304)
Lima (*Acesta*) *obliquissima* Tate	
Exogyra imbricata Krauss	(300, 301, 302, 303)
Trigonia herzogi (Goldf.)	(289)
,, *holubi* sp. nov.	(285, 286, 287, 288, 290, 291, 292, 293, 294, 295, 296, 299)
,, *vau* Sharpe	
,, *conocardiiformis* (Krauss)	
Tancredia schwarzi sp. nov.	
Meretrix uitenhagensis sp. nov.	
Actæonina atherstoni (Sharpe)	
Holcostephanus cf. *atherstoni* (Sharpe)	
,, *rogersi* sp. nov.	

Specimens of the following, in the South African Museum, are also believed to have come from the Sunday's River:—

Trigonia kraussi sp. nov.
,, *stowi* sp. nov.
Holcostephanus atherstoni (Sharpe)
,, cf. *baini* (Sharpe)

Specimens from Sunday's River, in the collection of the Geological Society of London:—

Holcostephanus baini (Sharpe)		
,,	*modderensis* sp. nov.	(Modder Drift)
,,	*wilmanæ* sp. nov. ...	(Aasvogel Krantz, above Modder Drift. Specimen numbered 10975A.)

(4) Coega River.

(*Collected by Mr. A. W. Rogers*, 1905.)

a. Wash-out 100 feet above Coega station at a point one mile north of Coega Hotel.

Nucula uitenhagensis sp. nov. .... (441g)
Trigonia sp. .... (438g)

b. From valley east of railway, 1 mile up the line from Coega station.

Mytilus uitenhagensis sp. nov. .... (479g)
Trigonia herzogi (Goldf.) .... (474g)
,, *rogersi* sp. nov. .... (472g)
Astarte longlandsiana Tate .... (477g)

c. Left side of Coega Valley, half a mile down from the railway.

Serpula pinchiniana Tate .... (458g)
Pecten orbicularis J. Sow. .... (453g)
Lima (*Acesta*) *obliquissima* Tate .... (455g)
,, (*Mantellum*) *neglecta* Tate .... (448g, 449g, 453g)
Trigonia holubi sp. nov. .... (458g)
,, *ventricosa* (Krauss) .... (463g)
Cardita nuculoides Tate .... (466g)

Anthonya lineata sp. nov. .... (461g)
Cyprina borcherdsi Tate..................... (467g)
Trapezium ? tatei sp. nov. .... (452g)
Meretrix uitenhagensis sp. nov............. (453g, 454g)

d. Left side of Coega Valley, 2 miles down from the railway.

Trigonia herzogi (Goldf.) ....(468g)

(*Collected by Miss M. Wilman.*)

e. Coega River.

Astarte (*Eriphyla*) *pinchiniana* Tate
Pecten (*Camptonectes*) *projectus* Tate

f. Coega.

Exogyra imbricata Krauss
Grammatodon jonesi (Tate)
Thetironia papyracea (Sharpe)
Pleurotomaria sp.
Holcostephanus atherstoni (Sharpe)
Belemnites sp.

The following are in the collection of the South African Museum, from Coega:—

Exogyra imbricata Krauss
Patella caperata Tate

(5) Knysna.

(*Collected by Mr. A. W. Rogers*, 1905.)

Brentford, Knysna Estuary.

Trigonia holubi ? sp. nov. [young individual] ...... (150h)
Acanthodiscus sp. .... (151h)
Belemnites sp... (153h)

The names of all the fossils mentioned above are brought together in a synoptic list at the end of the following Section (VI.) of this memoir.

(B). *LIST OF INVERTEBRATE FOSSILS FROM THE UITENHAGE SERIES, NOT REPRESENTED IN THE COLLECTIONS EXAMINED.*

Isastræa antipodum Tate
Cidaris pustulifera Tate
**Serpula sp.* (two species)
**Berenicea antipodum* Tate
Pteria baini (Sharpe)
**Pecten rubidgeanus* Tate
**Gervillia dentata* Krauss
**Pinna sharpei* Tate
**Placunopsis imbricata* Tate
* ,, *subjurensis* Tate
,, *undulata* Tate
**Exogyra jonesiana* Tate
Mytilus jonesi Tate
Modiola atherstoni Sharpe
,, *rubidgei* Tate
Lithodomus stowianus Tate
Cucullæa kraussi Tate
Grammatodon atherstoni (Sharpe)
Seebachia bronni (Krauss)
**Ptychomya complicata* (Tate)
Cyrena ? baini Sharpe
Trapezium nivenianum (Tate)
Pleuromya lutraria (Krauss)
**Pholadomya dominicalis* Sharpe
Corbula ? rockiana Tate
Trochus baini Sharpe
Monodonta hausmanni Neum.
Neritopsis ? turbinata Sharpe
Natica atherstoni Sharpe
Turritella rubidgeana Tate
Alaria coronata Tate
Nautilus sp.
Hamites africanus Tate
**Hoplites subanceps* (Tate)
Crioceras spinosissimum (Hausm.) Neum.
Belemnites africanus Tate

The above list is given as far as possible with corrected nomenclature, but some of the names are still subject to revision, though in nearly all instances I have been able to see either the original types or other satisfactory specimens. In the case of *Pinna sharpei* no specimen was seen by Tate, and the species was founded upon a drawing made by Stow from a specimen collected by another geologist. The names marked with an asterisk have received some brief mention in the second section of this paper.

In addition to the above, the following forms have also been recorded from the Uitenhage beds :—

Sanguinolaria ? africana Sharpe
Turbo stowianus Tate
Phasianella ? sharpei Tate
Chemnitzia africana Tate
Ampullaria ? ignobilis Tate
Actæonina jenkinsiana Tate
,, *morrisiana* Tate
,, *sharpeana* Tate

The materials upon which these names are based are for the most part unsatisfactory, and in several cases consist of small shells which were figured by Sharpe, though considered by him to be unfitted for specific determination. *Sanguinolaria ? africana* is a small shell of doubtful generic position, and the species may perhaps be founded upon an immature individual. *Turbo stowianus* has never been figured, and I have not been able to find the specimens described by Tate. *Phasianella ? sharpei* is a minute shell, and its generic position cannot be determined. *Chemnitzia africana*, founded upon a single individual, has not been figured, and I have not found the type-specimen. *Ampullaria ? ignobilis* is the name given by Tate to a very small shell figured by Sharpe, but the specimen cannot be found and its generic position is quite uncertain. The three forms ascribed by Tate to *Actæonina* are represented by specimens of minute dimensions figured by Sharpe. These determinations, like those above mentioned, are quite unsatisfactory; the specimens are probably immature, and in any case it is evident that more than a single genus is represented.

A comparison of the names of the Mollusca in all the above lists with those in the list given by Mr. R. B. Newton in 1896* shows an apparent want of agreement in some few items, and for convenience of reference these may be briefly noted here. *Reineckia subanceps* of Mr. Newton's list is the shell I have referred to *Hoplites*. In place of *Actæon* (for *A. atherstoni*) I have been led to use *Actæonina*, since the shells in question show no trace of plication on the columella; it has also been possible to show that *Turbo baini* must now be considered as a synonym of *Turbo atherstoni*. To substitute the name *Turbonilla* in place of Tate's *Chemnitzia* must be regarded as hazardous in view of the fact that the original determination was unsatisfactorily established. In place of *Cyprina*, Mr. Newton used *Arctica*, a name which is unfortunately preoccupied, even were there any valid objection to the employment of the familiar and long-established name *Cyprina*. *Ceromya papyracea* is now shown to be referable to *Thetironia*. Tate's *Crassatella complicata*, as pointed out by previous writers, belongs to the genus *Ptychomya*, and the emendation to *Crassatellites* is therefore incorrect. *Cucullæa cancellata* in Mr. Newton's list is a synonym of *Cucullæa kraussi* Tate, and was no doubt retained through oversight. In the case of *Cucullæa ? jonesi* and *Parallelodon atherstoni*, which may be

* Newton (2), pp. 150, 151.

referred to a single genus, I have employed the name *Grammatodon.* The selection of a correct name for these and similar Mesozoic forms might possibly be regarded as still debatable, but in this matter I have deferred to the opinion of Mr. H. Woods—a view with which Dr. Wheelton Hind is now also in agreement. In the choice between the generic names *Gari* and *Psammobia* opinions are divided, but I have given reasons for preferring to retain *Psammobia* (for *Ps. atherstoni*), although this course cannot perhaps be strictly justified, except as a measure of expediency to meet the circumstances of this particular instance. In the case of *Avicula baini,* the generic name *Pteria,* which has the prior claim, is used in one of the above lists. *Gryphæa imbricata* we have seen to be more correctly referable to *Exogyra,* to which it was originally assigned by Krauss, and I have pointed out that there is no foundation whatever for the inclusion of the name *Trigonia goldfussi* in any list of molluscs from the Uitenhage Series.

It should be remarked that the errors to which some of the discrepancies above noted are due, are such as must almost inevitably occur in a list of fossils which is compiled from previous works, with attempt at revision, without the examination of actual specimens, even though the task of compilation be carried out as carefully as in Mr. Newton's paper.

VI.—SUMMARY.*

General Results.—The great majority of the invertebrate fossils collected from the Uitenhage Beds consist of marine Mollusca, and have been obtained from localities in the valleys of the Sunday's, Zwartkop's, and Coega Rivers. The present study has shown that these marine fossils in reality furnish evidence which enables us to estimate their geological age with considerable precision. A more detailed examination of the fauna than that undertaken by Neumayr fully corroborates that author's conclusion that a large number of the Mollusca show affinity to Cretaceous rather than to Jurassic forms. The broad question of age which has given rise to such widely different expressions of opinion is, in fact, decisively answered by the occurrence of representatives of the following genera: *Holcostephanus* (sensu stricto); *Hamites; Crioceras; Bochianites; Acanthodiscus; Trigonia* (divisions Scabræ and Pseudo-quadratæ);

* See also Kitchin (2).

Ptychomya; Thetironia; Anthonya; Solecurtus, and *Meyeria.* Further, there is found to be no support whatever for the suggestion occasionally put forth, that the Uitenhage Marine Beds may correspond to a part of both the Upper Jurassic and the Lower Cretaceous series of Europe. So far as the palæontological evidence goes, there appears to be every probability that the strata yielding the marine fossils were deposited with comparatively great rapidity, and there is no indication of such diversity in the character of the fauna as would be consistent with the supposition that more than the equivalent of one palæontological stage is represented. Some of the typical marine forms are now known to have a much more extensive vertical range in the series than was formerly suspected, and the sameness of character in the fauna observed at different levels in the series seems to preclude any attempt to establish zonal divisions. It may be inferred that the Marine Beds were rapidly accumulated, and that they represent a very restricted period of time.

Amongst the Uitenhage Mollusca, the Gasteropoda constitute the least important element in a comparative study, while the Cephalopoda furnish the most significant evidence by reason of their close alliance with forms having well-restricted vertical range in Europe. The Lamellibranchiata largely preponderate in the fauna, and prominent amongst these are *Trigoniæ* which represent divisions of the genus as yet unknown to occur in Europe. While many of the lamellibranchs afford data which are valuable in supporting the evidence yielded by the Cephalopoda, in a correlation with European standards, some of the best-characterised bivalves are of very great interest from the fact that they and their close allies have an extensive geographical distribution, and enable us to bring the Uitenhage Series into broad correlation with deposits situated in widely separated regions outside the European area.

Correlation of the Fauna.—A detailed comparison with the Secondary faunas of Europe has shown that, despite the presence of some few bivalve forms which not remotely resemble familiar Jurassic types, there is abundant evidence in support of the opinion of those German writers who have ascribed to the Uitenhage Series a Lower Cretaceous age. Only a very small proportion of the Mollusca can be definitely identified with European forms, but a considerable number are closely comparable with Neocomian and Aptian shells. This is true of many of the lamellibranchs, which nevertheless, as might be expected, would alone afford comparatively scanty data for a precise correlation of the Uitenhage beds with members of the

Lower Cretaceous series in Europe. A surer guide may be recognised in some of the Cephalopoda, more especially in the representatives of *Holcostephanus* (sensu stricto) which so preponderate in the Uitenhage cephalopod-fauna. It is obvious that these have very near allies in Europe which are confined to the Upper Valanginian and Lower Hauterivian, and this fact may suffice to justify the provisional approximate correlation of the Marine Beds with this part of the Neocomian.

In the attempt to trace relationships between the Uitenhage molluscs and those of Lower Cretaceous deposits in extra-European regions, the desirable evidence to be derived from a comparison of cephalopod-types is as yet not forthcoming, if we except the single case of *Holcostephanus schenki* (Oppel), from the Spiti Shales, which is closely allied to some of the South African *Holcostephani*. Certain well-characterised lamellibranchs, on the other hand, some of which are of a very specialised nature, point to the bonds by which this development of the Neocomian in Cape Colony is connected with the Oomia *Trigonia*-beds of Cutch, the strata yielding *Trigonia ventricosa* in the Godavari district and in Hazara (Himalayas), the Neocomian deposits of German East Africa, and the Lower Cretaceous strata of presumably like age in Chili, Bolivia, and the Argentine Republic. In comparing the faunas, importance must be attached to the evidence of some of the *Trigoniæ*, notably of the divisions Scabræ and Pseudo-quadratæ. In particular, the points of contact revealed by a comparison of the lamellibranch-fauna of the Uitenhage Series with that of the Oomia *Trigonia*-beds are found to be very remarkable, and of such a kind that we must infer the approximate contemporaneity of these two faunas, and the existence of facilities for intercourse between the two areas. It becomes, therefore, a matter for some surprise that the Uitenhage ammonitoids or forms closely allied to them are as yet unknown in Cutch, and the real or apparent absence of such forms from the Neocomian deposits of German East Africa and of South America is also a striking circumstance.

The Relation of the Fauna to some Questions of Distribution.—A careful comparative study of the Uitenhage Mollusca dispels the idea, emphasised by Neumayr, that this fauna proclaims its isolated position by the sharp contrast it affords to the comparable faunas of other regions, and that it may therefore be considered to support the theory of an Indo-African land barrier in early Cretaceous times. Neumayr laid principal stress upon the contrast between the fauna of the Neocomian Belemnite-beds in the north-west of Madagascar

and that of the Uitenhage Series. It is probable, however, that this contrast may be due to a difference of facies, and in any case the argument derivable from it is greatly weakened, if not rendered valueless, by the relation seen to exist between the Uitenhage molluscan assemblage and that of the more truly comparable faunas in East Africa and Cutch. There are other facts also which are known to cast doubt upon the existence of an effective barrier to migration between the equatorial and southern waters to the east of the African continent, in Cretaceous times.

Neumayr laid great stress upon the occurrence of *Belemnites africanus* in the Uitenhage Series in support of his theory of the distribution of cephalopods according to climatic zones. He found this form to belong to a group which, though occurring in the colder waters of the northern hemisphere, appeared to have no representatives in the warmer equatorial regions. While the known distribution of *Holcostephanus* (sensu stricto) might at first thought be considered to support in a similar manner the broad principle laid down by Neumayr, it would certainly not be justifiable to attach any such significance to the facts. Our knowledge is as yet very incomplete, but a body of evidence relating to the distribution of fossil Cephalopoda has now been accumulated, which casts the strongest possible doubts upon the soundness of Neumayr's theory. Hence it will be well to exercise the greatest caution in the attempt to estimate the significance of the Uitenhage Cephalopoda in any general question of distribution. The apparent absence of identical or closely related forms from the Neocomian rocks of German East Africa and of Cutch is in all probability owing either to our imperfect acquaintance with the fossil faunas in these districts, or to conditions of a local nature which may really have determined the absence of such forms, in manner not unknown among the Cephalopoda of various geological horizons within restricted areas in Europe.

LIST OF THE FOSSILS COMPRISED IN THE COLLECTIONS SPECIALLY DEALT WITH IN THE FOREGOING PAGES.

The genera and species are arranged alphabetically under their respective classes. Their arrangement under localities is set forth in the lists at the end of the previous section of this memoir.

ANTHOZOA.

ANNELIDA.

LAMELLIBRANCHIATA.

GASTEROPODA.

CEPHALOPODA.

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EXPLANATION OF PLATES.

The figures are of natural size except when the amount of enlargement is specially stated in the explanations. The numbers in parentheses refer to the register numbers on the specimens. The specimens are in the South African Museum except when otherwise stated.

Plate II.

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2, 3.	*Pecten* (*Syncyclonema*) *orbicularis* J. Sow.	65
	2. Left valve. Sunday's River (279); 3, right valve, portion of surface above the middle of the valve on the posterior side, × 4. Sunday's River (280).	
4.	*Pecten* (*Camptonectes*) *cottaldinus* d'Orb.	65
	Right valve. Cliff below old school-house on the right bank of Sunday's River, Dunbrodie (306).	
5.	*Pecten* (*Camptonectes*) *projectus* Tate	66
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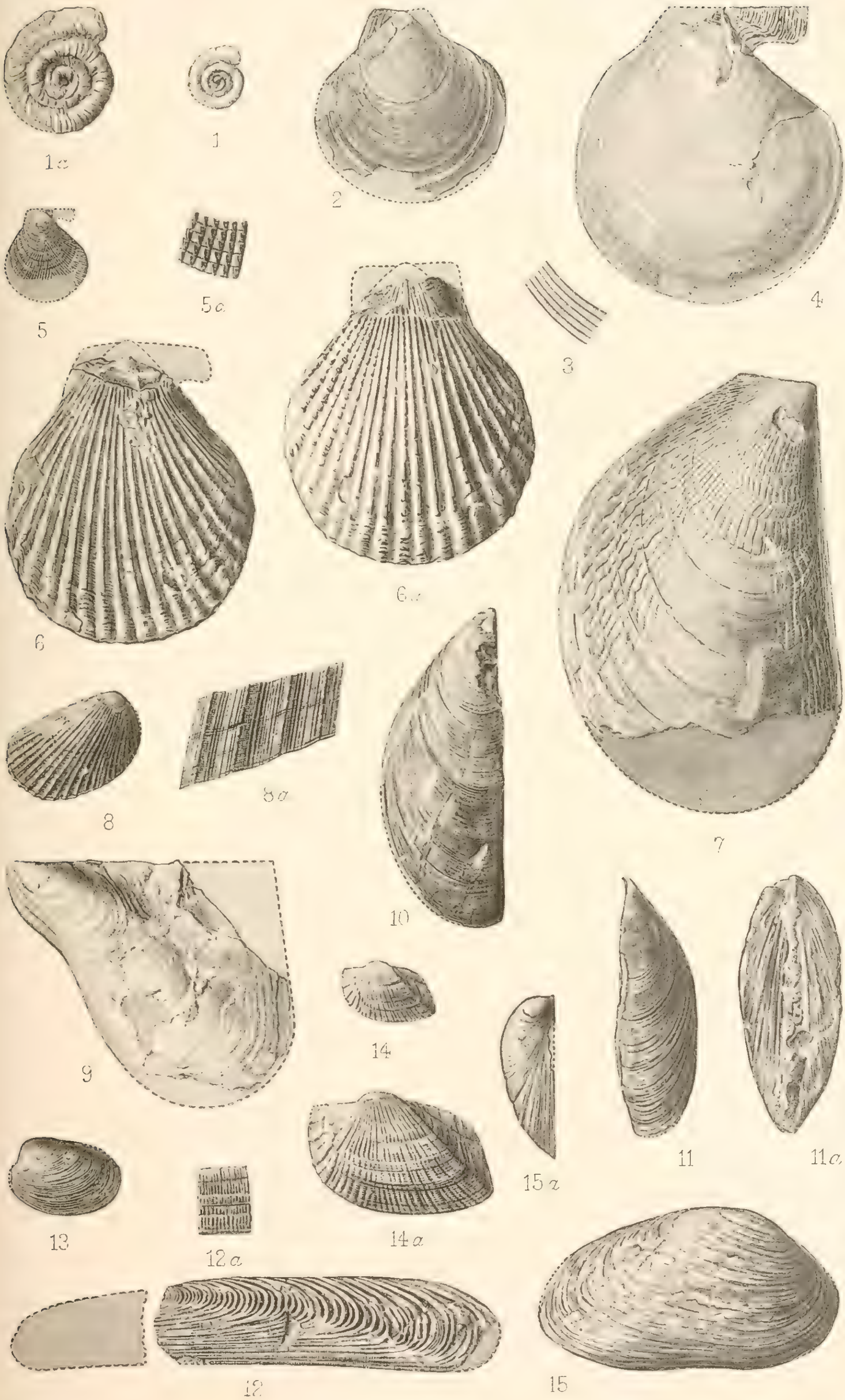

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Fossils from the Uitenhage Series.

Plate III.

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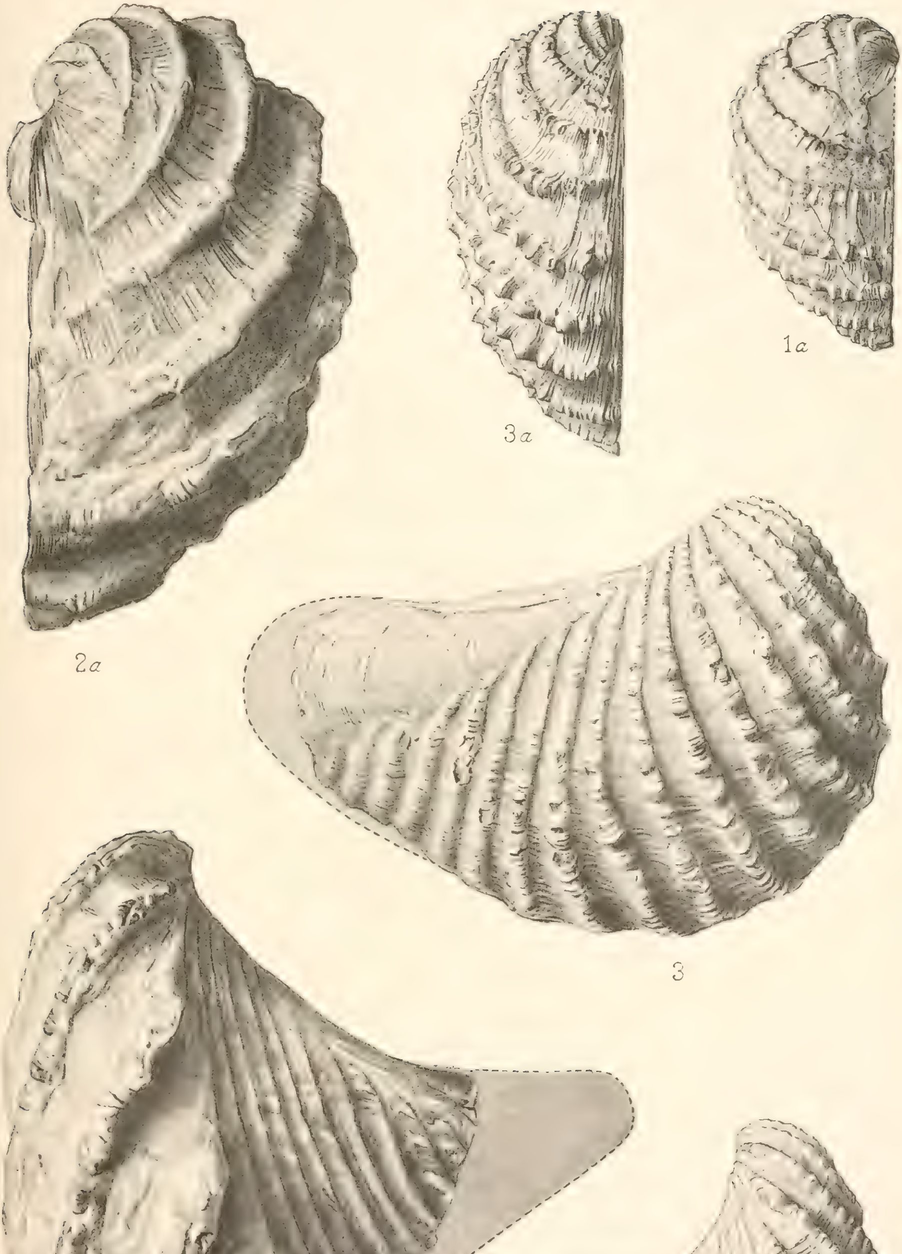
	3. Right valve; 3*a*, frontal aspect. Bare slope W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop (20h).	



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Fossils from the Uitenhage Series.

Plate IV.

FIGS.		PAGE
1.	*Trigonia rogersi* sp. nov.	99
	Dorsal view. Bare slope W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop (20h).	
2.	*Trigonia holubi* sp. nov.	103
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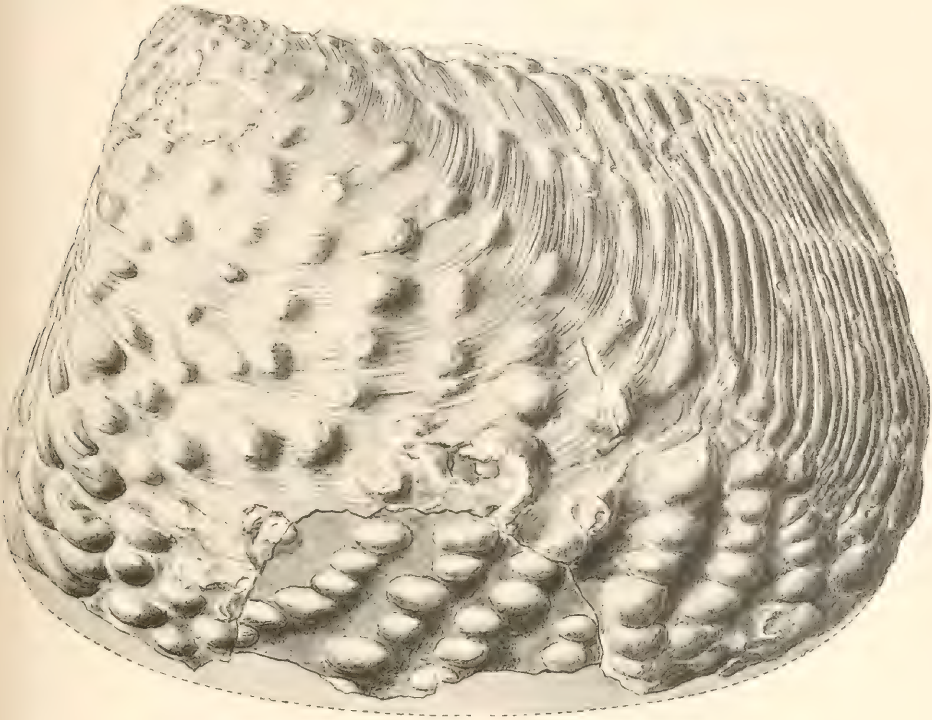

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2a

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Fossils from the Uitenhage Series.

Plate V.

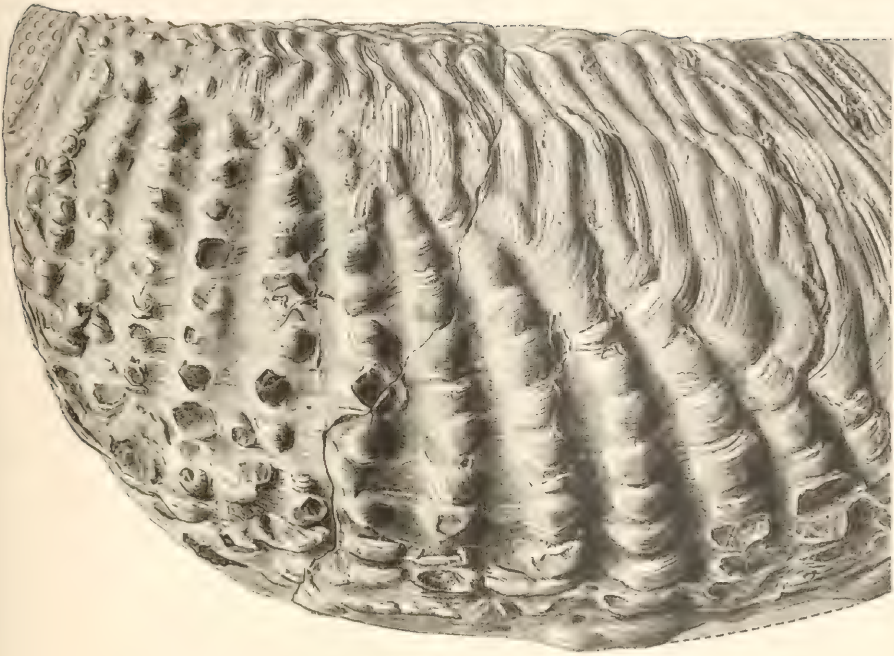
FIGS.		PAGE
1.	*Trigonia herzogi* (Goldf.)	101

Left valve of a large individual, posterior part not shown. Sunday's River (289), South African Museum collection. In the figure, the umbonal region is restored from another specimen (99h).

The ornaments of the area are well preserved, and show the gradual acquirement of the transversely costate character at a comparatively early stage. In *T. holubi* sp. nov., the change takes place more suddenly and at a later growth-stage.

2.	*Trigonia rogersi* sp. nov.	99

Left valve. Coega Valley, east of the railway, one mile up the line from Coega station (472g).



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Fossils from the Uitenhage Series.

Plate VI.

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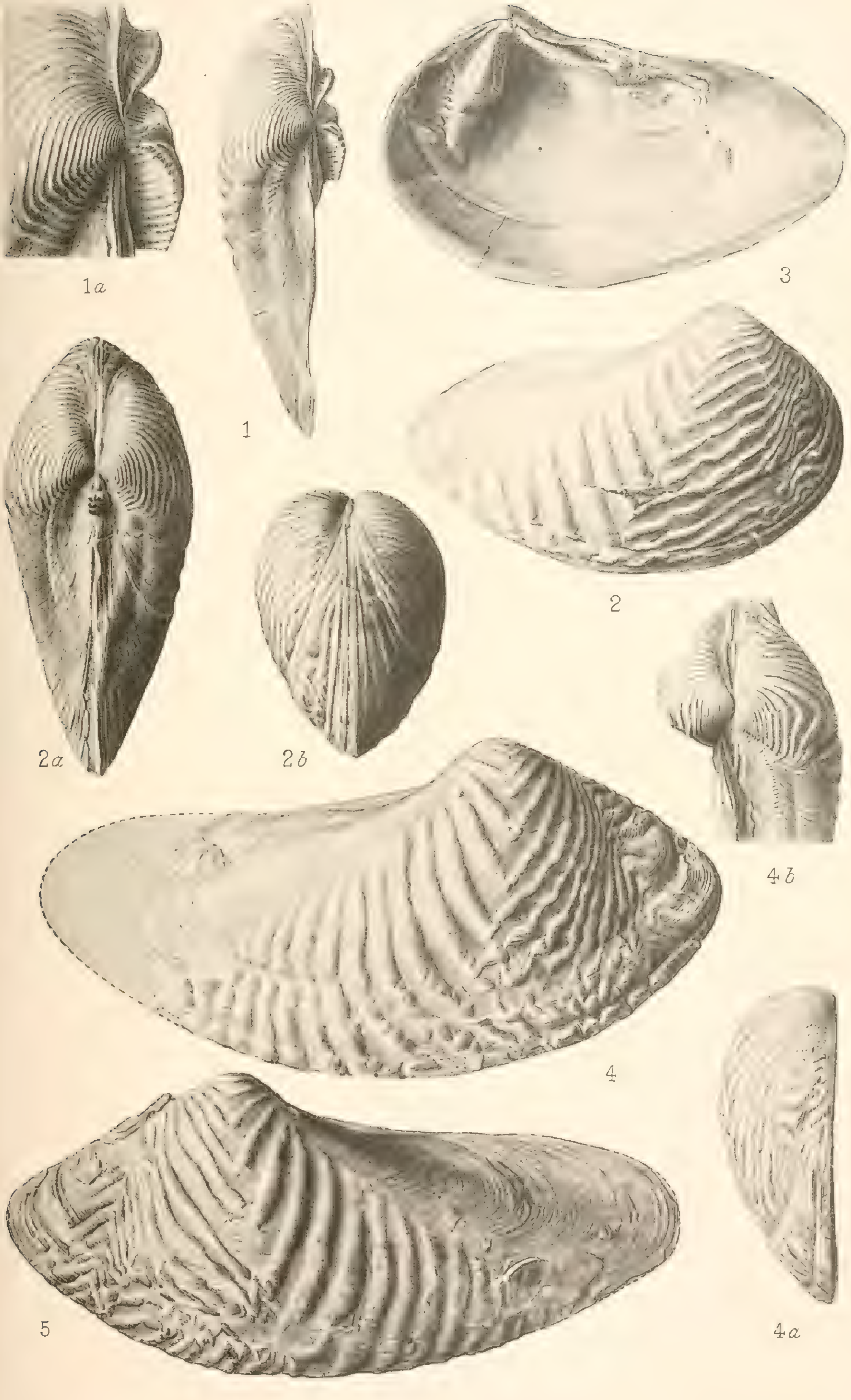
1–3. *Trigonia vau* Sharpe... 110

1. Left valve, dorsal aspect; 1*a*, umbonal region of the same valve, × 2. Three hundred yards below Addo Drift (Tunbridge's), left bank of Sunday's River (41h).
2. Right valve; 2*a*, dorsal aspect; 2*b*, frontal aspect. Same locality (40h).
3. Interior of a right valve. Same locality (42h).

4, 5. *Trigonia stowi* sp. nov. 115

4. Right valve; 4*a*, frontal view; 4*b*, dorsal aspect of the umbonal region of right valve and fragment of left valve, showing details of sculpture. Above Modder Drift, Sunday's River. In the collection of the Geological Society of London (No. 12006).
5. Left valve. From the South African Museum collection; probably Sunday's River.



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Fossils from the Uitenhage Series.

Plate VII.

FIGS. PAGE

1. *Trigonia stowi* sp. nov. 115

Right valve. Cliff W. 20 S. from Comley's House, Sunday's River (90h).

2–4. *Trigonia conocardiiformis* (Krauss) 119

2. Left valve; 2*a*, dorsal aspect; 2*b*, the same, × 2. Cliff on the right bank of Sunday's River, on Commando Kraal (104h).
3. Left valve. Sunday's River.
4. Left valve, incomplete posteriorly. Railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the line from Uitenhage to Graaff-Reinet, about three miles from Uitenhage (297). To compare with fig. 3, for rib-development. A fragment of *Serpula pinchiniana* Tate is adhering to the valve.

5. *Cardita nuculoides* Tate 127

5. Left valve; 5*a*, frontal aspect; 5*b*, portion of surface ornamentation from the middle of the lower half of the valve, × 10. Left side of Coega Valley, half a mile down from the railway (466g).

6. *Astarte* (*Eriphyla*) *pinchiniana* Tate 135

6. Right valve; 6*a*, umbonal part × 2, showing concentric sculpture. Coega River.

7, 8. *Anthonya lineata* sp. nov. 137

7. Cast of interior of a left valve. Bare slope W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop, Sunday's River (35h).
8. Drawn from a wax impression of the mould of the external surface of a left valve. Left side of Coega Valley, half a mile down from the railway (461g).

9, 10. *Tancredia schwarzi* sp. nov. 139

9. Left valve; 9*a*, frontal view. Cliff W. 20 S. from Comley's House, Sunday's River (95h).
10. Right valve. Kloof on the left side of Zwartkop's River, east-north-east of Red House (324).

11 *Thetironia papyracea* (Sharpe) 142

11. Right valve; 11*a*, portion of surface in the posterior half of the valve, × 2. Coega.

12. *Thetironia oblonga* sp. nov. 146

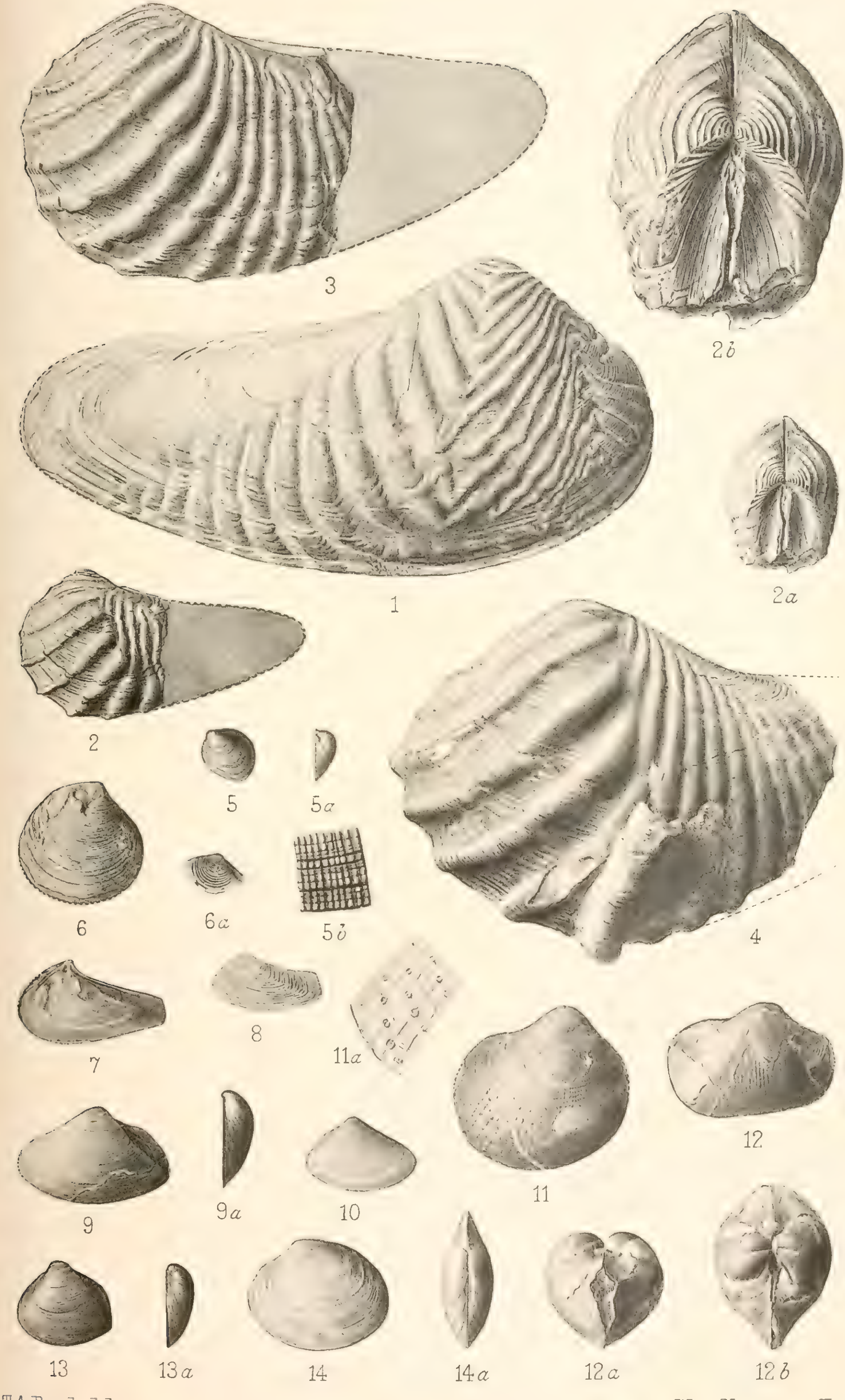
12. Right valve; 12*a*, frontal aspect; 12*b*, dorsal aspect. Kloof S. 5 W. from Comley's House, right bank of Sunday's River (83h).

13. *Trapezium? tatei* sp. nov. 148

13. Left valve; 13*a*, frontal aspect. Left side of Coega Valley, half a mile down from the railway (452g).

14. *Meretrix uitenhagensis* sp. nov. 151

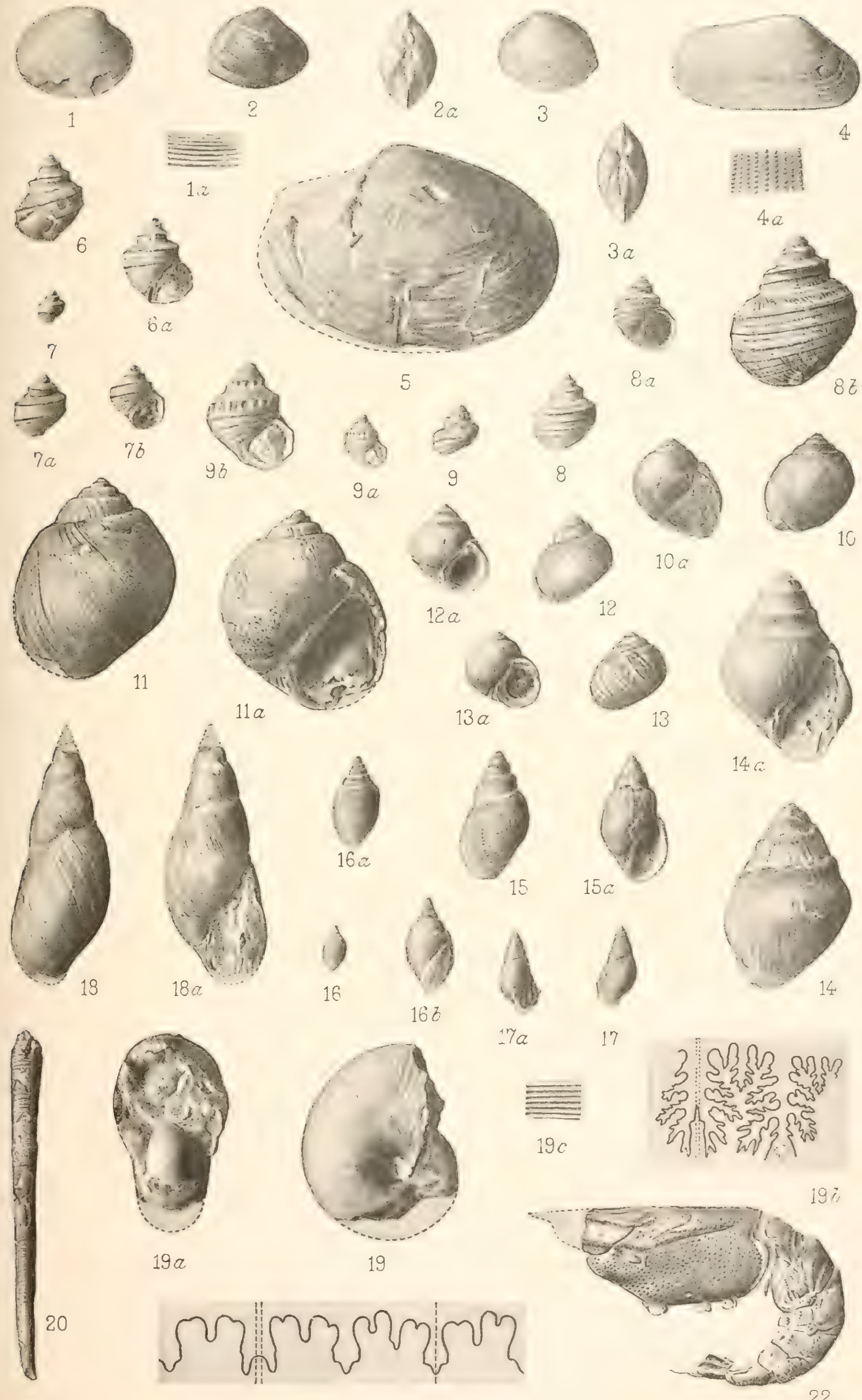
14. Left valve; 14*a*, dorsal aspect. Bare slope W. 30 S. from the middle of Barkly Bridge, on the farm Olifant's Kop, Sunday's River (30h).



T. A. Brock del. West, Newman collo.

Fossils from the Uitenhage Series.

Plate VIII.



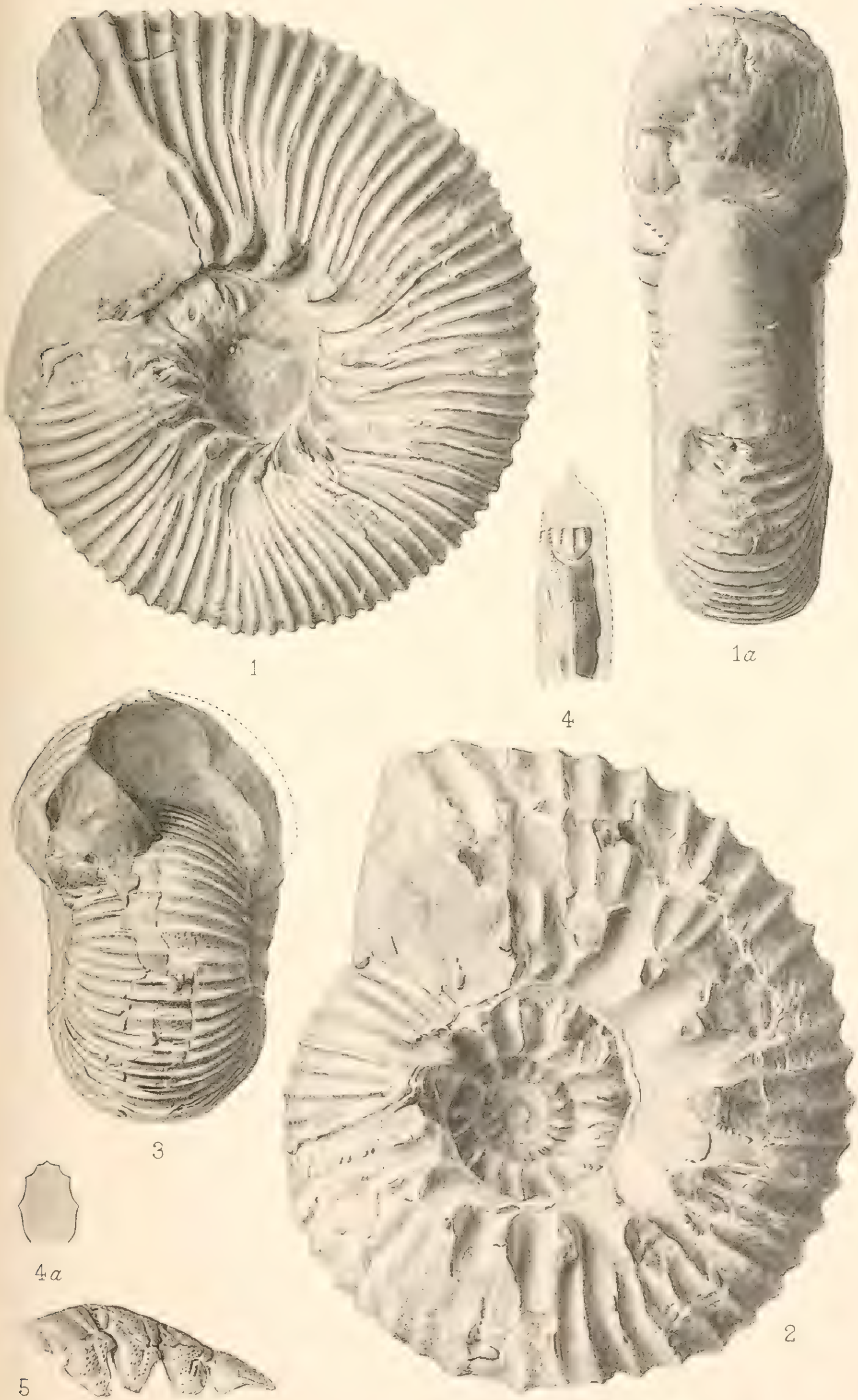
T. A. Brock del.   West, Newman collo.

Fossils from the Uitenhage Series.

Plate VIII. (*continued*).

*

PLATE IX.



T. A. Brock del. West, Newman collo.

Fossils from the Uitenhage Series.

Plate X.

FIGS.		PAGE
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2.	*Holcostephanus rogersi* sp. nov.	201
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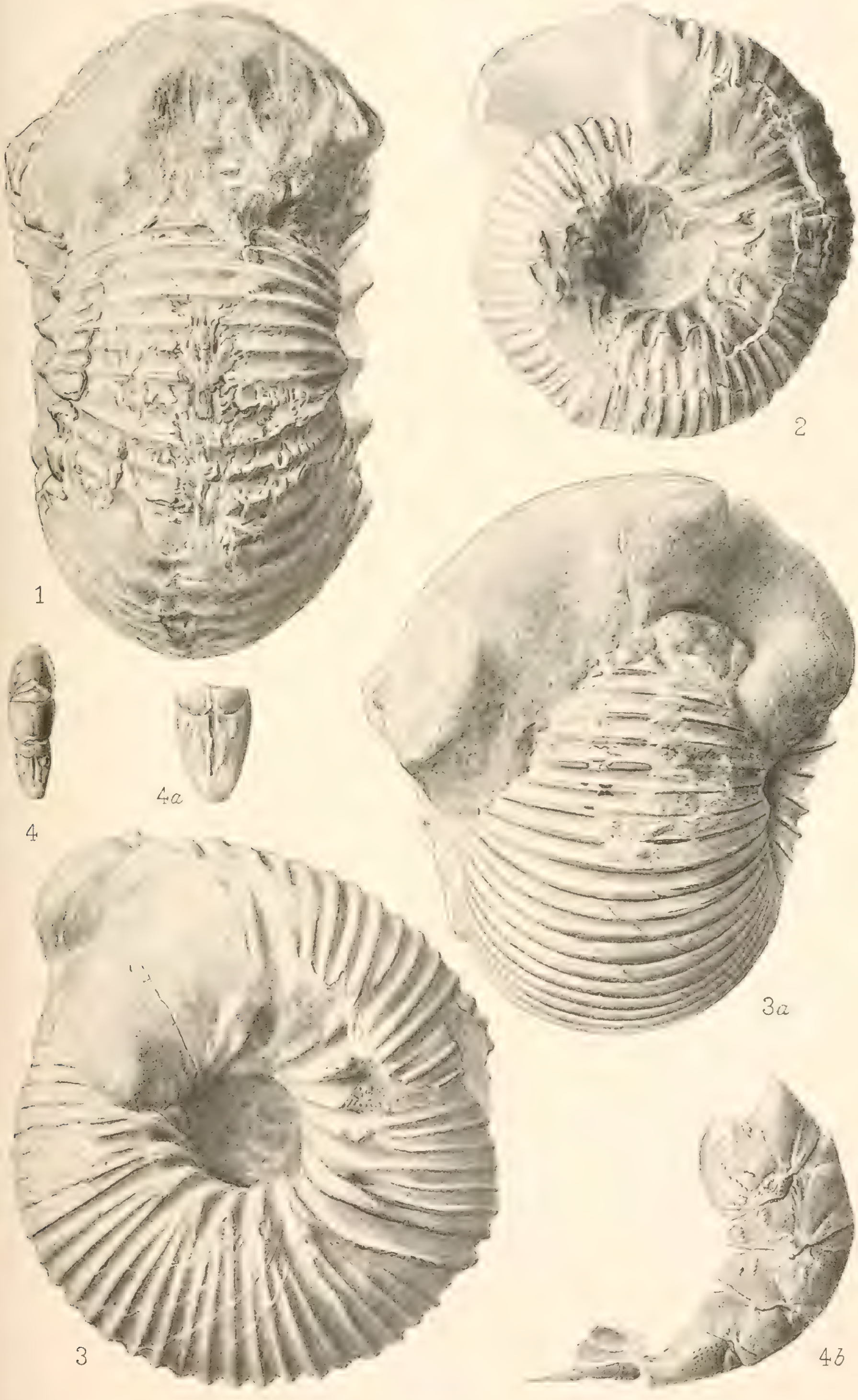
	4. Fifth and sixth abdominal segments and telson, viewed dorsally; 4*a*, telson × 2; 4*b*, lateral view of abdominal segments ii.–vii., with a trace of the swimming appendage of segment vi., × 2. The same specimen has already been shown in plate viii., fig. 22.	



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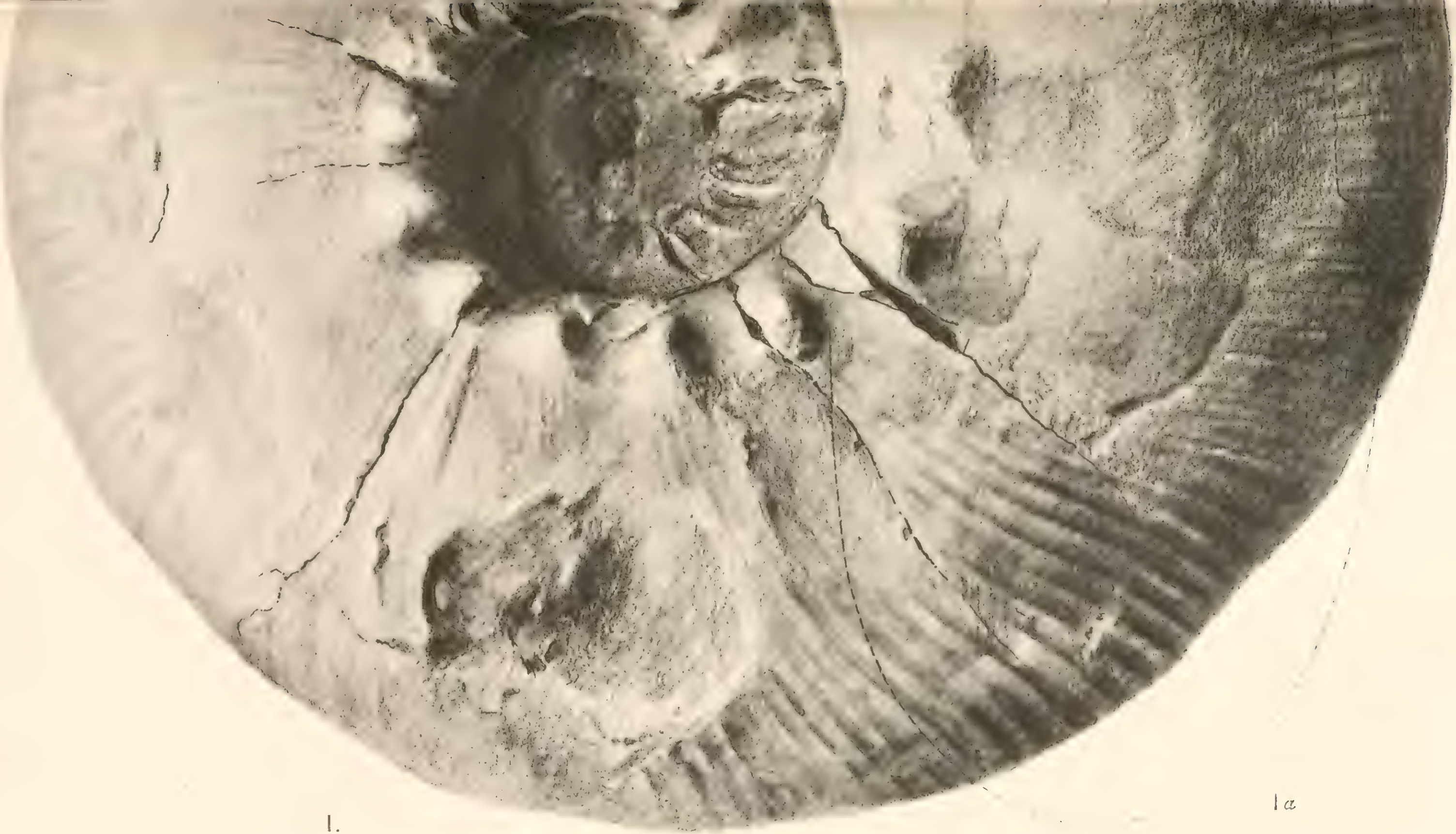
Fossils from the Uitenhage Series.

Plate XI.

FIG. PAGE

Railway cutting between milestones $24\frac{1}{2}$–$24\frac{3}{4}$ on the line from Uitenhage to Graaff-Reinet, about three miles from Uitenhage (276).

1*a*. Outline diagram of apertural aspect.



T A.Brock del.

West, Newman collo

Fossils from the Uitenhage Series.

4. (7)*.—*The Fossil Fishes of the Upper Karroo Beds of South Africa.*—By R. Broom, M.D., D.Sc.

(With Plates XII., XIII.)

Curiously enough almost nothing is known of the fishes of our marine formations. From the Bokkeveld beds (Devonian) a badly preserved fish spine is the only fish fossil as yet obtained, and so far no fish remains have been discovered in the Upper and Lower Cretaceous beds of Sunday's River and Pondoland. The fresh-water deposits of the Karroo have, however, a considerable number of interesting forms. One or two well-preserved fish have been obtained from the Dwyka shales, a few scales from the Ecca beds, and a number of badly preserved fishes from the Pareiasaurus beds. From the Middle Karroo beds a considerable number of specimens have been obtained. In a later paper I hope to deal with the fishes of these lower beds, reviewing the state of our knowledge, and describing one or two new forms. In the present paper I wish to deal with the fishes of the Upper Karroo beds, including the Upper Beaufort and Stormberg series.

All the fishes at present known from the Upper Karroo come from two horizons, by far the largest number having been obtained from the Rouxville district of the Orange River Colony. They occur in sandstone beds, which, with a high degree of probability, may be referred to the Upper Beaufort series, and may thus be of Upper Triassic Age. All the specimens of *Semionotus*, on the other hand, come from the Ficksburg and Ladybrand districts, from beds which are apparently Cave sandstone. If this is so then they most probably are of Lower Jurassic Age.

The collections which I have examined have been (1) a very fine collection obtained by Mr. Alfred Brown, of Aliwal North, from some locality near the Caledon River, O.R.C. ; (2) a fine collection obtained by Dr. Kannemeyer, of Smithfield, from Bekker's Kraal,

* This series of contributions is numbered paper 4 of vol. vii. The figures in brackets are the Nos. of Dr. Broom's contributions, the last of which, No. 6, appeared in Part VIII. of Vol. IV.

Rouxville district, O.R.C.; (3) a few specimens obtained by Mr. R. A. Albertyn from near Rouxville, and now in the Victoria College Museum, Stellenbosch; and (4) the very fine specimens of *Seminotus capensis* in the South African Museum obtained from Ficksburg by Chief Justice de Villiers.

HYBODUS AFRICANUS, n. sp.

In Mr. Brown's collection there are numerous fish spines, and one specimen shows much of the shagreen of the little shark with many teeth, but as in Dr. Kannemeyer's collection there is an almost complete specimen, though of a smaller animal than Mr. Brown's, I shall take as the type this specimen which Dr. Kannemeyer has presented to the South African Museum.

The specimen measures 230 mm. in length. The head is not well preserved, but the jaws are fairly distinct. One of the cephalic spines is preserved very similar in general shape to those figured by Smith Woodward in *H. medius* (1). The quadrate portion of the upper jaw is deep; the whole lower jaw apparently rather slender. If the most anterior part where shagreen can be detected is really the rostrum, then the mouth is situated well forward. The upper jaw is about 20 mm. in length. At about 43 mm. behind the supposed rostrum is a large shoulder girdle which, as preserved, is nearly 30 mm. in length and 8 mm. wide in its broadest part. Immediately above it is situated the base of the anterior spine. Unfortunately in the type specimen neither of the spines is well preserved. Behind the lower part of the girdle is a small flat area, which probably represents part of the pectoral fin. The anterior spine is situated about 46 mm. from the rostrum, and the second spine is 110 mm. behind the first. At a point 124 mm. behind the rostrum on the ventral side is a structure which probably represents the pelvic fin with a large clasper. It is, however, too indefinite to say anything of the detailed structure. Comparatively little of the axial skeleton can be made out. In the caudal region a number of hæmal spines are very clearly shown, and a large number of neural spines are indistinctly seen in the middle region of the body. In the abdominal region a little behind the shoulder girdle are indications of some curved slender structures suggestive of ribs. Perhaps they may be due to intermuscular septa.

One specimen obtained by Dr. Kannemeyer shows a dorsal spine and fin in splendid preservation. The specimen is too imperfect to show whether it is an anterior or posterior fin. The spine shows the posterior denticles and the ridging characteristic of *Hybodus*.

Behind the lower part is evidence of a large triangular place of cartilage, and behind it are seen very clearly 8 radials and perhaps a 9th, the last three resting on a longitudinal small additional cartilage. Some neural spines are also shown but less clearly. The arrangement of the radials is very similar to that in the specimen of *Hybodus basanus* figured by Smith Woodward (2), but this specimen is more complete.

The teeth are very small.

Cœlacanthus africanus, Broom.

This species was described in Rec. Alb. Mus., vol. 1, pt. v., 1905 (3), from two imperfect specimens in Mr. Brown's collection. No further specimens have been obtained, so that nothing more can be added to the description there given. I, however, here give a figure of the specimen.

Ceratodus capensis, S.-Woodward.

This species was described in Ann. and Mag. Nat. Hist., September, 1889, by Smith-Woodward (4) from a tooth obtained by Dr. Exton at Smithfield, O.R.C. Most probably the beds from which the type was obtained are the same as those in which most of the species described in this paper were found. In fact, the exact spot from which most of the fossils were procured is probably nearer to the town of Smithfield than to Rouxville.

Ceratodus kannemeyeri, Seeley.

This species was described by Seeley in the Geol. Mag., April, 1897 (5), from a specimen obtained by Dr. Kannemeyer. It is a large form with strong blunt denticles quite unlike either *C. capensis* or the following species.

Ceratodus ornatus, n. sp.

This new species is founded on a single mandibular tooth found by me at Vaalbank, near Burghersdorp. It is characterised by having four ridges, of which the anterior three have sharp angles of about 60°. There may be a small fifth. The front ridge is almost exactly equal in size to the 2nd and 3rd together. The second and third ridges have along the edge a row of small tubercles. All the ridges radiate from a single point.

The length of the 1st ridge is 12 mm. and the 2nd 11 mm.

A second small imperfect tooth, also from Vaalbank, is only about

half the size of the type specimen. It is probably an upper tooth. It has apparently had five ridges, and may belong to a different species. It is most probably an immature tooth.

Of described forms this Vaalbank specimen seems to come nearest to *C. serratus* and *C. Phillipsi* of Agassiz.

HELICHTHYS BROWNI, g. et sp. n.

This interesting little Palæoniscid is represented by a considerable number of specimens in Mr. Brown's collection, by one or two in the collection sent to the South African Museum by Dr. Kannemeyeri, and by one or two specimens in the collection of the Victoria College. Many of the specimens are very well preserved, and almost every detail of the external anatomy is revealed in one or other. For the type I have taken one of Mr. Brown's specimens, which, though without the tail, is the most perfect otherwise.

General Form.—Most of the specimens measure about 90 mm. in length, and the body is about 18 mm. deep behind the pectoral fins. The length of the head with the opercular apparatus is about 21 mm. The dorsal and anal fins are well developed and triangular, the dorsal being very slightly in advance of the anal. The tail is typically Palæoniscid.

Head and Opercular Apparatus.—The skull differs from that of the majority of Palæoniscid genera in having the suspensorium, as in *Amblypterus*, nearly vertical. The frontal bone is long and narrow, and each is traversed by a sensory canal which opens on the surface by a series of foramina. On the outer side of each frontal are, as in *Nematoptychius* as figured by Traquair (6), a posterior frontal and an anterior frontal, to use Traquair's names; and in front of the frontals doubtless a median ethmoid. It is not well preserved in any of the specimens, but in one the place for it is well shown between the anterior frontals. Immediately behind the frontals are a pair of small parietals. These are relatively smaller than in *Palæoniscus* and considerably smaller than in *Nematoptychius*.

The supratemporal region has hitherto been only known in a very few Palæoniscids. In *Palæoniscus* Traquair says (6, p. 21): "The presence of a narrow *supratemporal* chain of ossicles behind the posterior margin of the cranial buckler is probable, though not satisfactorily exhibited in any specimen I have had the opportunity of examining. I have, however, observed what seems to me to be decided traces of their presence in *Palæoniscus*, and . . . I have indicated them in dotted lines [in the figure]." In *Elonichthys pectinatus*, however, he discovered a series of well-developed

supratemporal ossicles, which he describes as follows (7, p. 83): "Between the posterior margin of the cranial shield and the post-temporal element of the shoulder girdle we obtain a good view of the supratemporal chain of ossicles so seldom seen in a Palæoniscid head. Of these three are shown, namely, two belonging to the left, and one . . . belonging to the right side of the head; while traversing all these three we observe an elevated line showing the course of the supratemporal slime canal, which here, as in the salmon and many other fishes, forms a transverse commissure between the right and left main canals." These observations in two different Palæoniscids are extremely interesting in connection with the somewhat similar but different condition in *Helichthys*.

In *Helichthys*, behind the parietals are a pair of large supratemporals which have a long median suture, and behind these a second pair of supratemporals, small and narrow, and wedged in between the large supratemporals in front and the post-temporals behind. The commissural sensory canal lies entirely in these second small supratemporals. Along the outer side of the parietal and the large supratemporal and in front of the anterior end of the small supratemporal lies the large squamosal, along the middle of which is continued the sensory canal from the small supratemporal. In front of the squamosal are apparently a number of orbital ossicles not satisfactorily preserved, and the sensory canal a little in front of the squamosal bends abruptly down and passes through the ossicles behind the eye. Further it cannot be traced.

Below the squamosal is a moderately large triangular bone presumably corresponding to the bone marked *x* in Traquair's figure of the head of *Elonichthys* and called an accessory piece. Below this triangular bone is a large preopercular, and adjoining this latter in front and below is the maxilla, which is fairly long and slender in front and bears a large number of small teeth. The dentary is long and bears many small teeth, which are arranged irregularly on the upper and inner margin of the bone.

The operculum is an oblong bone situated below the squamosal and the smaller supratemporal. Below it is the large interopercular, followed by the branchials. These latter are not well preserved in any of the specimens examined. The first three or four are well seen in the type, but the others appear always to lie inside of the mandible, and are thus hidden.

Most of the surface bones of the head are ornamented, but the details of the sculpturing differ in different specimens. The mandible has on the front part of the lower two-thirds of the outer side a large

number of short irregular longitudinal ridges. In the posterior part of the bone the ridges are mostly vertical. A similar ornamentation is present on the maxilla, preopercular, and opercular, and to a less extent on most of the other surface bones. The frontals, parietals, and supratemporals are, however, nearly smooth.

Appendicular Skeleton.—The shoulder girdle is not unlike that of *Palæoniscus*, though the proportions of the different elements differ considerably. The post-temporal is a small bone which lies behind the second supratemporal. It is only very slightly ornamented. The supraclavicle is a large oblong bone which is divided into two very unequal parts by the lateral line which crosses it obliquely, separating the upper and posterior corner from the lower part. The anterior and inferior large part is beautifully ornamented by a series of 5 or 6 wavy ridges running down it, while the small upper part is unornamented. The lateral line has in its course through the bone 7 or 8 foramina. Both the clavicle and the interclavicle seem stouter than in *Palæoniscus*, but otherwise they are similar in structure so far as can be seen. Both are beautifully ornamented by ridges of ganoine. The postclavicle is considerably longer than in *Palæoniscus* and is smooth. The infraclavicle is well developed and ornamented.

The pectoral fin is not fully preserved in any of the specimens. It consists of at least 10 rays—probably considerably more—of which the second is the longest. All are unarticulated, and they appear to be unbranched even at their tips, but the specimens are not sufficiently well preserved to admit of certainty on this latter point. In the front of the fin are powerful fulcra, which occupy a space rather larger than that occupied by the first three rays.

The pelvic fin is about half the size of the pectoral and is formed of about 12 rays, which are articulated at their bases but apparently not distally. There is no evidence of branching in either of the two specimens showing the fin. Small fulcra lie on the front of the fin and occupy a space a little greater than that occupied by one ray.

Unpaired Fins.—The dorsal fin is situated far back, and nearly opposite the anal. It consists of 21 rays, of which the 7th and 8th are the longest. All the rays are articulated, but though distally they are much flattened, they are not manifestly branched. A number of small fulcra are present on the front of the upper part of the fin. A couple of enlarged scales are present on the dorsum in front of the fin.

The anal fin is slightly longer than the dorsal. It consists of 34 rays, of which the 8th is longest. All the rays are articulated

and unbranched. Fulcral bones are present on the front of the distal half of the fin.

The caudal fin is lost in the type specimen, but from other specimens it is seen to agree closely with the caudal of the following species.

Squamation.—The scales on the sides are rhomboidal, with the inferior borders somewhat convex and the posterior borders nearly straight and smooth. The posterior angle is slightly produced. The scales on the abdominal region are narrower and closely imbricated. All the scales are practically smooth.

While most of the specimens are of the same size as the type, one which I cannot distinguish specifically is considerably larger, measuring 140 mm. in length. It is not well preserved and may prove to be distinct, but so far as can be seen there is no distinct difference except in size from the typical *H. browni*.

The genus *Helichthys* seems well differentiated from any other previously described. The other genera of Palæoniscids with the suspensorium nearly vertical are *Canobius*, *Gonatodus*, *Drydenius*, *Amblypterus*, and *Eurylepis*, and of these only *Amblypterus* seems to have any close affinity. Further, all are Carboniferous genera except *Amblypterus*, which is also found in the Permian Age. From *Amblypterus*, *Helichthys* differs in having a feebler tail, and in having the fin rays not or only slightly branched.

Helichthys draperi, Smith-Woodward.

In 1893 Smith-Woodward (8) described under the name *Dictyopyge* (?) *Draperi* a fossil fish from Rouxville, O.R.C. The type specimen has lost the tail, and Smith-Woodward was in doubt whether to regard the species as a Palæoniscid or a Catopterid, but provisionally placed it in the genus *Dictyopyge*. In Mr. Brown's collection is a fairly well-preserved specimen which shows that the fish is undoubtedly a Palæoniscid and enables me to add to the original description.

Mr. Brown's specimen measures 133 mm. in length and 28 mm. in depth, while the head measures 27 mm. in length. The head is not very well preserved, but the specimen shows that the suspensorium is, as in *Helichthys browni*, nearly verticle. The mandible is long and slender, as is also the anterior part of the maxilla. The opercular bones are large and smooth, but the anterior frontal region has a considerable amount of rugose ornament. The shoulder girdle is not well preserved, but has apparently little or no ornamentation.

The pectoral fin has 16 rays articulated in the distal half and

branched distally. Small fulcra are present in front. The pelvic fin is badly preserved. The dorsal fin is almost wholly in front of the anal. It has about 25 rays. I cannot detect any fulcra in front of it, but the condition of the fin is somewhat unsatisfactory.

The caudal fin is deeply bifurcated, the upper lobe being the longer. Along the top of the upper lobe is a row of specialised ridge scales, but they are not much larger than the other scales of the tail. All the rays of the caudal fin are articulated and branched.

The scales of the side of the body are about as deep as broad. The lower and posterior margins are both straight, but the posterior one is distinctly serrated in the scales of the anterior half of the body. From the serrations on some of the scales there run forwards for a short distance a few feeble ridges.

While there may still be some doubt as to the genus of this species it can confidently be stated that it cannot be referred to *Dictyopyge*. Nor do I think it can be placed in the genus *Rhadinichthys*, which is characterised by having the suspensorium very oblique. Though the fin rays differ a little from those of *Helichthys browni*, the general structure of the skull so far as known is so similar that it seems advisable to place this species in the same genus as the other.

Helichthys tenuis, n. sp.

This very well-marked species is represented by only one specimen, and that a badly preserved. The fish is fairly complete, but it is so much weathered that little remains beyond the impression.

The complete fish probably measures 90 mm., and the greatest depth is 16 mm. The head measures 16 mm. Though in general structure it agrees with *H. browni*, and most probably belongs to the same genus, it differs from that species in being more slender, in having the dorsal and anal fins much smaller, and in having the peduncle of the tail much longer.

The head agrees fairly well with that of *H. browni*, but is longer in proportion to the height. The pectoral fin is smaller than in the type species and has apparently 18 rays. The dorsal fin is also smaller, but has a larger number of very delicate rays—apparently 30. No distinct fulcra can be detected. The fin is situated only very slightly in front of the anal. Like the dorsal the anal fin has many delicate rays—probably 36. The caudal fin is not preserved, but the distance from the posterior part of the anal to the front of the caudal fin is at least 13 mm. In the type of *H. browni* the corresponding distance is only 5 mm.

In the collection obtained by Dr. Kannemeyer there is a tail with the dorsal and anal fins, which almost certainly belong to this species.

OXYGNATHUS BROWNI, sp. nov.

Of this large Palæoniscid fish there is only one good specimen in the collection which will be taken as the type. There is, however, a second smaller specimen of which much of the head is preserved and the anterior half of the body. It is difficult to compare the two specimens, and it is thus not quite certain that the two belong to the same species. As, however, the two are at least closely allied, and probably represent the same animal, the second specimen will be used for the description of the cranial characters.

General Form.—The type specimen when complete probably measured 310 mm. in length, and the greatest depth of the trunk is 75 mm. The dorsal, anal, and caudal fins at least are large and powerful, while the scales are relatively small and thin.

Head and Opercular Apparatus.—In the type specimen only the upper and back part of the head is preserved. The opercular is large and rhomboidal, and about a half longer than broad. In front of it lies a narrow preopercular, about half the width of the opercular. Above these two bones is a large squamosal imperfectly preserved. Between the upper part of the opercular and the preopercular is apparently a small triangular bone agreeing in position with the bone figured as "hyomandibular" by Traquair in his figure of the head of *Oxygnathus ornatus*, but I do not think it can be regarded as hyomandibular in the present specimen as it is finely tuberculated like the opercular bones, and thus presumably a membrane bone. Most probably it corresponds to the element marked *x*, and called a "supplementary plate" by Traquair in his restoration of the head of *Elonichthys pectinatus*. Only a small part of the subopercular is preserved.

In the second specimen the ocular and preocular regions are missing, but the posterior half is fairly well preserved. The surface of the bones is weathered off, but well-marked impressions of many of the bones remain. The opercular at its widest part measures 8 mm., and its greatest length over the long diagonal is about 18 mm. The subopercular is about a half broader than deep. Immediately below it are the series of branchials. There are 19 preserved, and it is unlikely that more than one or two are missing. Immediately in front of the opercular and subopercular is a long narrow hyomandibular exposed by the removal of the "sup-

plementary ossicle," and part of the preopercular. The hyomandibular measures 20 mm. in length, and is constricted in the middle. It supports a very small quadrate, and there appears to be a distinct symplectic. The preopercular lies along the upper side of the maxilla. The squamosal lies above the opercular, the hyomandibular, and the preopercular. Behind it is a narrow supratemporal dividing it from the post-temporal. The sensory canal is continued from the lateral line over the supraclavicle and can be seen crossing the squamosal. The maxilla and the dentary are well developed and have two series of teeth, an outer row of small irregularly arranged teeth, and an inner row of large well-spaced laniaries.

Axial Skeleton of Trunk.—The axial skeleton of the posterior half of the larger specimen is well preserved. There is clear evidence of the persistence of the notochord. In the middle region of the body a series of short neural arches are well displayed. The height of the arches is about equal to the diameter of the notochord. In the posterior region the arches are much obscured by the scales. Above each arch is a slender spine about twice the length of the arch. The head of each arch is dilated and the lower end of each spine similarly expanded to articulate with it. The middle part of each spine is slender, but the ends seem to be expanded, but they are not well preserved. The spines can be traced back into the tail. In the region of the dorsal fin a row of short interspinous bones are displayed, of which eight are clearly seen. Above these and articulating with them is a second row of interspinous bones arranged along the base of the dorsal fin. Of these there are probably 20, and they are all somewhat hour-glass shaped, about three or four times as long as broad.

In the region below the anterior part of the dorsal fin are seen a few hæmal arches. Like the neural arches they are short, and like them articulate with long hæmal spines. The hæmal arches cannot be traced beyond the plane of the back part of the dorsal fin, but the spines can easily be traced into the tail. In the region of the posterior part of the anal fin they are rather feeble, but become much more strongly developed where they are required to give support to the lower lobe of the caudal fin. The anal fin is supported by a single series of long interspinous bones, many of which are curved to fit the ends of the hæmal spines.

The condition of the neural and hæmal arches, spinous and interspinous bones will be seen to be essentially similar to those described by Traquair in *Pygopterus* and *Nematoptychius*. He says: "I can find no clear evidence of the presence of two sets of interspinous

bones in the anal." In the Palæoniscid fish I am describing there is pretty conclusive evidence that there is only one set, unless the other be extremely rudimentary.

Appendicular Skeleton.—In the type specimen the shoulder girdle is only represented by the upper part of the supraclavicle and the post-temporal, and these are very badly preserved. In the second specimen much of the shoulder girdle is seen in good condition. The supraclavicle is of large size, and the lateral line passes over the upper part of it. The postclavicle is small, but distinct. The clavicle is well developed. The rays of the pectoral fin are distinctly articulated distally, but it is not clear whether the proximal halves are also articulated.

The pelvic fin is seen in the type specimen, but it is very imperfectly preserved.

Unpaired Fins.—The dorsal fin begins a little in front of and ends opposite the middle of the anal fin. It is large and triangular, and is formed by about 40 rays, of which the 8th is the longest and the first 3 very short. They are articulated throughout their whole length. Most of the rays divide near their middle and again at the beginning of their distal fourth. A series of small fulcra support the front of the fin, and one or two enlarged scales lie in front of the anterior end.

The anal fin has a longer attachment than the dorsal, and the rays are rather longer. They are about 52 in number, and the 8th and 9th are the longest. Like those of the dorsal fin, they are articulated and branch dichotomously.

The caudal fin is somewhat imperfectly preserved. It is probably fairly deeply bilobate, but neither the upper nor the lower lobe is complete, and the two portions are artificially separated from each other. The lower lobe is well developed, the rays being supported by large hæmal spines. The upper caudal lobe is well developed.

Squamation.—The scales of the body are small and rather thin. Those of the anterior part, which are better developed, are rhombohedral, and ornamented with 8 or 9 little irregular ridges which pass backwards and slightly downwards. The scales of the abdominal region are very narrow and closely imbricated. Those of the posterior part of the body are thinner and smaller. On the upper lobe of the tail the scales are again thicker and form long, narrow rhomboids ornamented by a few oblong ridges passing backwards.

A few enlarged scales lie in front of the dorsal fin, but apparently

there are none before the anal or caudal. Above the tail are, however, a row of very large fulcral scales.

While this large Palæoniscid seems different from any previously described form, it is a little difficult to be sure in what genus it ought to be placed. It resembles to some extent the New South Wales genus *Apateolepis* and to a less extent the genus *Myriolepis*, but it seems to agree so much more closely with the English Liassic genus *Oxygnathus*, that I think it better to place it, at least provisionally, in that genus. The only points in which the South African fish does not agree with Smith-Woodward's definition of the genus *Oxygnathus* are in having the ridge scales of the upper caudal lobe large and in the body scales being rather thin.

Dictyopyge formosa, n. sp.

This new species is represented by a single specimen in the collection obtained by Dr. Kannemeyer. It is a small species, measuring only about 70 mm. in length, and the head 14 mm. The body has a greatest depth of 13 mm.

The head is not sufficiently well preserved to enable one to say much about its structure. The orbit is placed well forward, and both the maxilla and the dentary are long, and each has a row of small uniform teeth.

The pectoral fin is composed of about 11 rays, of which the 4th is longest and the first 3 short. There are well-developed fulcra in front. The fin rays are not manifestly branched, and it is doubtful if they are articulated. The pelvic fin is not well preserved. The dorsal fin is only very slightly in front of the anal. It is composed of 24 rays, of which the 8th is longest. There are no fulcra. The anal fin is composed of about 36 rays, of which the 8th is the longest. A few fulcral rays are present in front of the distal part of the fin. The caudal fin is slightly imperfect, but enough is preserved to show that it is a variety of the abbreviate heterocercal. The axial portion of the upper lobe is longer than in typical *Dictyopyge*, but distinctly not *Palæoniscid*.

The scales are well developed and rhomboidal. They are characterised by the presence of two prominent ridges, which are directed backwards. The dorsal scales are perhaps slightly enlarged, and two large scales lie in front of the dorsal and at least one in front of the anal.

Semionotus capensis, Smith-Woodward.

In 1888 Smith-Woodward (9) described, under the above name, some fossil fishes from the Stormberg beds of the Drakensberg Range.

Though the specimens were in fair preservation, so many very much finer specimens have since then been discovered that it is now possible to add a good deal to Smith-Woodward's description, and also to modify one or two details.

The finest specimens are believed to have come from near Ficksburg in the Orange River Colony, and good examples are to be found in most of the South African museums. The finest I have seen are those in the Cape Town collection.

The majority of specimens measure from 160 to 210 mm. in length. In the example which is 210 mm. long, the body is 42 mm. in depth at the deepest part, and the head measures 48 mm. to the back of the operculum.

E. Schellwien (10) has recently described a number of specimens from the Orange River Colony, and has shown the more important features of the skull structure. The specimens I have examined confirm most of his observations, but in one or two points I am inclined to differ from him. Schellwien's specimens show one or two features not seen by me in those I have examined, while I am able to add a number of characters not observed by him.

Almost every detail of the skull is now known except the basicranial region. The frontals are large, and extend from the nasal region to behind the plane passing through the back of the orbit. The back part of the bone is about twice as wide as the middle portion. Behind it is a large oblong parietal. Below the parietal is a slightly narrower squamosal. My specimens do not satisfactorily show the supratemporal region, but Schellwien finds a narrow supratemporal and a post-temporal.

The opercular bones are very like those of *Lepidotus*. The operculum differs in being relatively considerably wider in its lower half. Inferiorly it joins the subopercular in a manner very similar to that in the better known genus. The subopercular in *Semionotus* is only about one-third the size of the operculum instead of half as large as in *Lepidotus*, while the interopercular is less than half the size of that in *Lepidotus*. In front of these three opercular bones is a narrow curved preopercular, along which there runs a mucous canal.

In Schellwien's diagrammatic restoration the postorbital seems to me to be rather too small, while the interopercular is much too large. Above the anterior end of the long preopercular is an elongated suborbital smaller in size than the postorbital. The portion of the figure dealing with this region is, in my opinion, erroneous.

I should be inclined to restore the anterior portion of the skull

somewhat differently from Schellwien, but my material is too unsatisfactory to decide the matter.

The lower jaw has an elongated triangular dentary and a powerful angular.

The palato-pterygo-quadrate arch is fully ossified, but the exact limits of the different element cannot be made out with certainty. There is a long narrow bone below the quadrate stretching from the articular region to the lower end of the hyomandibular. This would seem to be the symplectic. The hyomandibular is a powerful bone and fairly similar to that of the ordinary Teleosteans. In addition to supporting the opercular bones and the quadrate arch, it supports the hyoid arch. There is a large quadrangular epihyal and an elongated triangular ceratohyal. The interhyal has probably been cartilaginous, as has also probably been the hypohyal and the urohyal. Under the subopercular are six branchiostegals.

The clavicular arch consists of the clavicle, supraclavicle, post-clavicle and post-temporal, but there seems to be no trace of an infraclavicle. A mucous canal crosses the supraclavicle obliquely as in the Palæoniscids. There is a small ossification which possibly may he the coracoid as is thought by Schellwien.

The pectoral fin consists of 14 rays with 5 or 6 fulcra in front. The rays are much flattened distally, but apparently not branched.

The pelvic fin consists of 7 rays which are branched distally. The fulcra are powerful.

The dorsal fin begins exactly in the middle of the back of the fish and consists of 13 rays, of which the last 3 are very small. All the rays are branched distally and articulated. In front are a row of very powerful fulcra, 9 in number. The anal fin consists of 9 rays with 9 powerful fulcra in front.

The caudal fin consists of 16 rays, all of which are branched and articulated. Below and in front of the first ray are 14 fulcra, and 14 fulcra also lie above the tail, gradually passing into dorsal scales in front. The rays of the dorsal, anal, and caudal fins are double. Though the tail is in a sense brevi-heterocercal the upper portion is really continued as a long, slender process bearing small rhombic scales about 20 mm. beyond the end of the middle of the tail.

All the specimens of *Semionotus capensis* are believed to come from Stormberg beds, and to be thus of lower Jurassic Age.

Cleithrolepis extoni, Smith-Woodward.

This remarkable deep-bodied Ganoid was described in 1888 by Smith-Woodward from specimens found at Rouxville. Though the

type is a fairly well-preserved specimen there were a number of points left in doubt which can now be settled. I have only seen three specimens of this species and only one approaching perfection. Though the head is fairly well preserved it is very difficult to make out the sutures owing to the large numbers of ganoine tubercles scattered over the bones. In the numerous specimens of the following allied species the cranial details are somewhat better seen.

The operculum and subopercular are well preserved in a number of specimens, the latter being nearly twice the size of the former. In front of these lies a large curved bone about half the width of the operculum and extending from the level of the upper border of the operculum to the middle of the subopercular. Smith-Woodward in characterising the genus *Cleithrolepis* (B. M. Cat., vol. iii., p. 155) states, "the preoperculum narrow and almost covered by the suborbitals." I feel satisfied this is not the case in *Cleithrolepis minor* at least, for in it down the relatively broad preopercular runs the sensory canal in almost exactly the same way as is seen in the preopercular of *Semionotus*. The circumoculars are small bones which form a ring round the orbit, the one at the upper and posterior corner of the orbit being the largest. A canal seems to run up over the head in the supratemporal region and another branch down the frontal and round the front of the orbit. Above the operculum there seems to be a fairly large squamosal traversed by the anterior continuation of the lateral line. And there is some evidence of a second canal running parallel to the other above it. In one of the specimens of *Cleithrolepis extoni* the parasphenoid is well seen. The maxilla and mandible are very short. If there is a distinct interoperculum it is very small. Three or four branchiostegal rays can be detected in one of the specimens of *C. minor*.

The pectorals are not preserved in any of the specimens of *C. extoni* I have seen though the place of attachment is manifest, and only a trace of the pelvic fin is preserved. In all three specimens the *dorsal* fin is nearly perfectly preserved. It consists of 20 rays with a series of small fulcra in front. The *anal* fin is shorter than the dorsal and consists only of 15 rays. Both fins extend to near the base of the tail. The caudal fin is large and symmetrical, but not very deeply cleft, and the longest rays are only a little longer than the longest of the dorsal and anal fins. There are altogether 30 rays in the caudal fin and a series of small fulcra both above and below, and all the rays are articulated and bifurcated distally.

The greatest length of the complete fish from the snout to the line

joining the tips of the tail is 100 mm., and the greatest depth from the highest point of the back to the base of the pelvic fin is 72 mm.

Cleithrolepis minor, n. sp.

The large majority of the specimens of *Cleithrolepis* are only about two-thirds the size of the type specimen of *C. extoni*. For some time I was inclined to consider all these as merely young specimens, but on careful examination they reveal sufficient points of difference to justify them being placed in a distinct species. In *C. extoni* the depth of the head is less than one-third the depth of the body; in *C. minor* it is almost half. In *C. extoni* the line of the back forms an obtuse angle a little nearer the front of the dorsal fin than the occiput; in *C. minor* the line of the back forms a gentle curve. In the former species the cranial bones and the scales are covered with tubercles; in the latter the tubercles are very slightly developed on the opercular and other cranial bones, and even of the scales they are relatively much smaller than in *C. extoni*. The tail in *C. minor* is much more deeply bifurcated, and the dorsal and anal fins are much smaller and do not extend so near to the base of the tail.

The largest specimen of *C. minor* measures 72 mm. in greatest length and 43 mm. across the body to the base of the pelvic fin. The dorsal fin has about 18 rays, the anal 12 or 13. The caudal fin has about 30 rays.

Hydropessum kannemeyeri, g. et sp. nov.

In Kannemeyer's collection there are two specimens of this beautiful little deep-bodied ganoid, and unfortunately both are imperfect. One specimen exhibits the upper two-thirds of the body including most of the head and the tail; the other shows the greater part of the body, but has very little of the head.

Though allied to *Cleithrolepis*, this genus differs in that it is extended up so that the edge of the dorsum makes nearly a right angle, and the ventral region is probably similarly produced, so that excluding the tail the body is apparently deeper than long. There is the further marked difference in that the dorsal fin begins at the upper angle of the back, and is a short fin with a very long base. In general appearance *Hydropessum* is thus strikingly like *Cheirodus*, but there is not the slightest doubt that it does not belong to the Platysomidæ, but is a near ally of *Cleithrolepis*.

The larger of the two specimens measures from the snout to a

line joining the tips of the tail 62 mm., and the greatest depth of the body is probably about 52 mm.

The cranial sutures are not distinctly seen for the most part, but there seems to be a fairly close resemblance between the general structure of the head in this genus and *Cleithrolepis*. The operculum and suboperculum appear to differ only in the operculum being perhaps rather smaller relatively. The preoperculum is even rather larger than in *Cleithrolepis*, and as in that genus a sensory canal runs down its posterior side. The circumorbitals are small. The frontal is large, and the maxilla short.

The dorsal fin is composed of at least 21 short rays, and extends from the dorsal angle about two-thirds down the posterior dorsal slope. A few small fulcra lie in front, but the rays are not sufficiently well preserved to show whether they are bifurcated and articulated. The caudal fin is deeply bifurcated, the rays of the upper and lower lobes being powerful, those of the middle region feeble. The tail is brevi-heterocercal.

The scales are rather larger than in *Cleithrolepis*, and differ in being ornamented not with tubercles, but with numerous small short ridges of ganoine which run vertically and are very irregularly arranged. The cranial bones are scarcely at all ornamented.

Of previously described ganoids *Cleithrolepis* seems to be the nearest ally of *Hydropessum*. *Dapedius* has a somewhat similarly extended dorsal fin, but the cranial structure is very different in the two. *Ætheolopis* differs in the remarkable developments of the fins and tail.

Pholidophorus browni, n. sp.

In Mr. Brown's collection there are two specimens of a small species of *Pholidophorus* and in Dr. Kannemeyer's two imperfect specimens of a second species, also apparently of the same genus.

The smaller of the two species, which I am naming after Mr. Brown, measures 74 mm. in length and 15 mm. deep at the pelvic fin. The front of the dorsal fin is situated exactly midway between the snout and end of the tail, and is only a short distance behind the front of the pelvic fin. The head with opercular apparatus measures about 14–15 mm.

The head is not well preserved in either specimen. The maxilla is slender in front and fairly deep behind. It bears about 14 elongated conical teeth, which cannot be described as in the typical *Pholidophorus* as "minute." Behind and above the posterior end of the maxilla is a large flat bone, or possibly two bones, which must

be suborbitals. The preopercular is narrow and overlapped by the suborbitals. The opercular is broad, but the division between it and the subopercular cannot be made out. A number of branchiostegal rays can be seen.

The dorsal fin is composed of apparently 16 rays with a few very small fulcra in front. The anal fin has at least 11 rays. The pectoral fin is badly preserved in both specimens, but the pelvic is well seen in the type. It has at least 6 rays, and there is a series of well-developed fulcra in front. The caudal fin is bifurcate but not deeply, and is nearly homocercal. It is formed of about 21 rays, and there are a number of small fulcra at least in front of the lower lobe.

The scales are in about 37 series and about 10 rows. The middle 3 rows in the front two-thirds of the body are roughly about twice as deep as the others, and these scales are distinctly serrated behind with about 10 teeth. From these teeth feeble ridges run forward on the scales a short distance, but otherwise the scales are smooth. There is practically no ornamentation on the bones of the head.

Conclusion.

With the exception of *Seminotus capensis*, which is believed to be of Stormberg Age, all the fishes here described belong to Upper Beaufort beds. The fishes collected by Dr. Kannemeyer and Mr. Brown are pretty certainly all of one horizon, and form one of the most interesting collections of fossil fish ever obtained. The Upper Beaufort beds with little doubt correspond to the Keuper of Europe. A species of *Cyclotosaurus* occurs at Rouxville, and a species of *Capitosaurus* at Burghersdorp, and there are many other facts which seem to confirm this determination of the age.

A comparison of this Karroo collection of fishes with those of the Hawkesbury of Australia is very interesting. In both faunas we have the genera *Dictyopyge*, *Cleithrolepis*, and *Pholidophorus*, and possibly when the Australian and African beds are more fully explored other common genera may be found. The Australian Palæoniscid genus *Myriolepis* may be regarded as the representative of the South African *Oxygnathus*. Still, in spite of the resemblances, the differences between the two faunas is more striking. In the Hawkesbury beds *Belonorhynchus* and *Pristisomus* are very prominent genera, yet quite unknown in the Karroo beds. On the other hand, the two most prominent genera in the South African beds—*Hybodus* and *Helichthys*—are unknown in the Australian beds.

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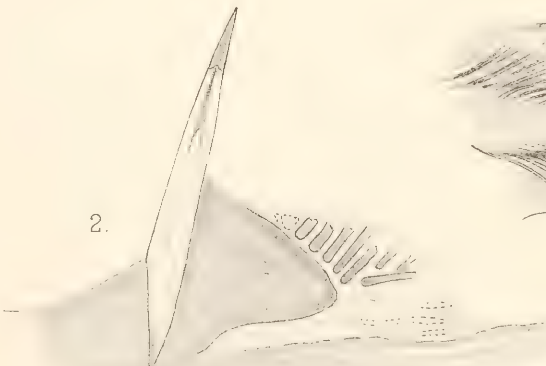

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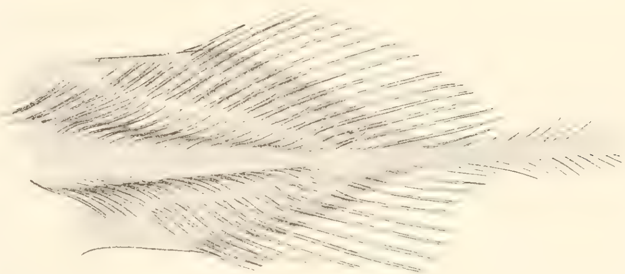

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Fig. 1 & 2. Hybodus Africanus. Fig. 3. Cœlacanthus Africanus.
Fig. 4. Ceratodus ornatus. Fig. 5. Hydropessum Kannemeyeri.

Fig. 6. Helichthys Draperi. Fig. 7. Helichthys Browni.
Fig. 8. Oxygnathus Browni. Fig. 9. Cleithrolepis Minor. Fig. 10. Pholidophorus Browni.

Besides the forms I have described, there are evidences of a considerable number of others, but the remains are too unsatisfactory for description.

I must express my indebtedness to Mr. E. S. C. Dyke for taking excellent photographs of the more important specimens.

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REFERENCES TO PLATES XII., XIII.

Fig.

1. *Hybodus africanus.* Slightly reduced.
2. *Hybodus africanus.* Anterior dorsal fin and spine. $\times \frac{1}{1}$.
3. *Cœlacanibus africanus.* Tail. $\times \frac{1}{1}$.
4. *Ceratodus ornatus.* Tooth (? mandibular.) $\times \frac{1}{1}$.
5. *Hydropessum kannemeyeri.* $\times \frac{1}{1}$.
6. *Helichthys draperi.* $\times$ almost nat. size.
7. *Helichthys browni.* $\times$ about $\frac{2}{3}$.
8. *Oxygnathus browni.* $\times \frac{2}{3}$.
9. *Cleithrolepis minor.* $\times$ about $\frac{2}{3}$.
10. *Pholidophorus browni.* $\times$ about $\frac{2}{3}$.

(8).—*Notice of some New South African Fossil Amphibians and Reptiles.*—By R. Broom, M.D., B.Sc.

(With one text figure.)

Trematosaurus kannemeyeri, n. sp.

The type of this new species is the centre part of a skull received from Dr. Kannemeyer and obtained by him in the Orange River Colony. Posteriorly it is broken obliquely across a little behind the orbits, and in front is broken through about 65 mm. in front of the orbits.

The skull is evidently that of an animal about twice the size of *Trematosaurus brauni*, and it has probably differed from the type species in having the snout relatively considerably longer.

The orbit measures 31 mm. by 20 mm., and the interorbital measurement is 49 mm. At the back of the orbit the width of the skull is 94 mm., and at transverse plane 60 mm., in front of the orbit 64 mm.

The surface of few of the bones is preserved, but where it is found it is seen to be pitted as in *T. brauni*, and a groove runs up the snout and passes along nearer to the middle line than to the orbit.

The frontal does not enter the orbital margin, and passes much further forward than in *T. brauni*, the anterior end being in advance of the portion preserved.

The prefrontal is large, and ends about 55 mm. in front of the orbit.

The postfrontal is long and narrow, and, so far as preserved, fairly similar to that figured by Burmeister in *T. brauni*.

The postorbital is peculiar. It forms 9 mm. of the orbital margin, but behind the orbit it becomes rapidly constricted till it measures only 4 mm. across, and then slowly widens out till it measures 13 mm. The preserved portion measures 43 mm. in length, and probably at least 10 mm. are missing.

The maxillary teeth are not well preserved. Where preserved they are small and uniform, and 8 occupy 11 mm.

The para-sphenoid (vomer) is very narrow.

The resemblances of this South African animal to *Trematosaurus brauni* are sufficiently great to leave little doubt that both should be placed in the same genus. The Spitzbergen Labyrinthodont recently described by Smith-Woodward as *Aphaneramma rostratum* has an elongated snout, but is not allied to the South African form.

Capitosaurus africanus, n. sp.

In the highest division of the Beaufort series—the Burghersdorp * or Cynognathus beds—remains of a moderate-sized broad-headed Labyrinthodont are rather common. Many fragments of jaws and teeth occur in Mr. Brown's collection, but I had not thought it wise to name the teeth, as there was little doubt that more perfect specimens would be obtained. Last year I was fortunate in discovering the greater part of the skull of this broad-headed form on the farm Vaalbank, near Burghersdorp, and though the specimen is incomplete, enough is preserved to enable one to refer it to the genus *Capitosaurus* with great probability. A few years ago I described another large flat-headed form from the same beds under the name *Cyclotosaurus albertyni*, considering with Fraas that it was at least convenient to keep this genus distinct from *Capitosaurus*. *Cyclotosaurus albertyni* is the giant Labyrinthodont of the Upper Karroo beds. It occurs at Smithfield, Aliwal North, and Burghersdorp. A large tooth, which does not seem distinguishable from that of *C. albertyni*, Seeley has recently made the type of a new genus and species.

The form to which I give the name *Capitosaurus africanus* is only about half the size of *Cyclotosaurus albertyni*, and differs in having the auditory notch open behind, as in *Capitosaurus nasutus* and most other Labyrinthodonts. In general it resembles *Capitosaurus nasutus*, but differs in having the exoccipital condyles nearly hidden by the superficial cranial bones, and in the prosquamosal (supratemporal) being relatively much larger.

As in *C. nasutus*, the jugal only forms a very small part of the orbit. The prosquamosal is so large that its outer and anterior angle is almost on the plane of the back of the orbit. The distance from the posterior border of the postparietal ("supraoccipital") in the middle line to the posterior border of the parietal is greater than the distance from the posterior border of the parietal to the pineal

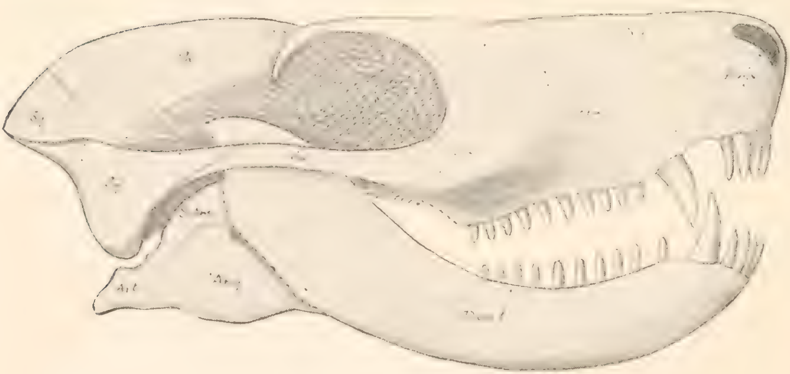
* Mr. du Toit is inclined to regard the Burghersdorp beds as including both the Cynognathus beds and the Procolophon beds. Lithologically it is doubtful if a distinction can be drawn, but the faunas are very different.

foramen—a character in which it differs from *C. nasutus.* The vomer ("parasphenoid") is narrow and flat, and markedly concave in its posterior part. In the posterior part of the mandible 6 teeth occupy 11 mm.

The following are some of the principal measurements :—

Length of mandible (estimated)	330 mm.
Width of skull	190 ,,
Width across occipital condyles	36 ,,
Width between orbits	38 ,,
Distance from orbit to tympanic notch	52 ,,
Width across the "epiotic" cornua	113 ,,

BAURIA CYNOPS, g. et sp. nov.



BAURIA CYNOPS. × $\frac{3}{4}$.

Some months ago I discovered on Mr. Lategan's farm, Vaalbank, near Burghersdorp, the almost perfect skull of a new type of Cynodont. The specimen was picked up at the foot of a little slope of debris, and no trace of the rest of the skeleton could be found. The specimen consists of the skull and first three cervical vertebræ, and is practically perfect with the exception of the back portions of each lower jaw, which have been weathered away, leaving only the impression in the matrix.

The skull, which is extremely mammal-like in general appearance, measures 134 mm. in length and 82 mm. in breadth. It differs from that of all previously discovered Cynodonts in having the orbits open behind, as in most mammals, and simple conical molars, as in most Therocephalians. On further examination it is seen that *Bauria,*

though a Cynodont, belongs to a more primitive family than any hitherto known.

The snout is, like that of typical Cynodonts, slightly narrowed behind the canines. The nasals are long and broaden out behind, as in *Gomphognathus.* In front they pass further forward, so that the nostrils look forwards and slightly outwards, so that, except for their being divided by an internasal septum, they are very mammal-like in appearance.

The orbits are relatively large, measuring 30 mm. by 24 mm., and the interorbital measurement is 26 mm. Each frontal bone is concave, so that there is a low median ridge and a ridge above each orbit. The frontal only forms a very small part of the orbit, the greater part of the upper margin being formed by the prefrontal. There is no postfrontal, but the postorbital is well developed. It forms the whole of the back of the orbit, but does not extend as far as the jugal. Posteriorly it only passes back on the parietal for a short distance. There is no trace of a pineal foramen. The parietals are anchylosed, and form a thick triangular roof to the brain cavity. On passing backwards they spread out and form the inner half of the posterior wall of the temporal fossa.

The squamosal is much smaller than in the typical Cynodonts. It is developed in four directions. The inner limb articulates with the parietal, and a second large flat process lies in front of the exoccipital. The third process descends to support the small quadrate, and the anterior process, which is short and slender, articulates with the jugal. The quadrate is probably similar to that in the other Cynodonts. It lies to the inside of the lower process of the squamosal, and apparently forms the whole of the articulation for the articular. To the inner side of the quadrate lies the tympanic bone, as in the Anomodonts and Cynodonts. It is an elongated rod, constricted in the middle and considerably dilated at both ends.

The jugal is slender, but extends far back. It has no ascending process. The lachrymal appears to be much smaller than the prefrontal.

The maxillaries are approximated, so that the distance between the alveolar margins is considerably less than between the outer margins of the nasals. There is a moderate-size round canine with no trace of serrations so far as preserved. Behind it are 10 somewhat conical teeth. They are somewhat flattened antero-posteriorly, so that they have oval sections, but there appear to be no trace of cusps or serrations. The space occupied by the 10 teeth is 31 mm.

The premaxilla is well developed, and is not overlapped by the maxilla, as in Therocephalians. It meets the nasal behind the nostril, and it forms a very short internasal process. There are four rounded incisors which, like the canines and molars, are, so far as preserved, without any trace of serrations or cusps. The space occupied by the incisors is 15 mm. The snout has been split in the middle line to show the relations of the vomer, prevomer, and palatine process, but it is impossible to be quite sure of all the details. The vomer is a large median bone, as in all Cynodonts, and it has the same relations behind the palatines and pterygoids. In front it lies above the secondary palatine plate of the maxilla, and passes forward to within 4 mm. of the root of the 1st incisor, where it lies above an elongated triangular bony process. Whether this bony process is palatine process of the premaxilla or not is doubtful. It seems to be continuous with the premaxilla, and may provisionally be regarded as the palatine process. It is remarkable for having a very large, apparently cavernous, space in it. I do not think the space has been for the accommodation of Jacobson's organ, as its walls are very irregular, and it is very near the roots of the incisors. It is too far back, on the other hand, to be a cavity for the development of a second tooth. Above it, and roofing it for the most part entirely, is a thin bone, which is most probably the septo-maxillary. The septo-maxillary is well seen in the floor of the nostril externally, and this flat plate of bone is apparently the inner continuation of the same bone. It is thus very doubtful whether there is any trace of the prevomer left, and there is no evidence of an organ of Jacobson. If this conclusion be correct, *Bauria* would agree in this with the Anomodonts and a number of mammals.

The palate is, so far as can be seen, exactly like that of the typical Cynodonts, and the structure of the posterior nares also similar.

The *basis cranii* is peculiar in that there are two prominent processes passing downwards and outwards from the basisphenoid, and probably giving support to the inner end of the tympanic. This is an arrangement differing somewhat from that of the typical Cynodonts but very similar to that seen in the Anomodonts.

The exoccipital forms a large transverse process, passing outwards towards the articular region, as in other Cynodonts. Doubtless above it lies the opisthotic. Near the inner end of the exoccipital is a large round foramen, situated exactly as in better-known Cynodonts. It seems to correspond to the large foramen behind the condyle in *Ornithorhynchus*, and probably served for the transmission of the 9th, 10th, 11th, and 12th nerves. The 12th nerve has in part a

distinct canal for itself, only joining the larger foramen at its exit.

The occipital condyle is in an extremely interesting condition, being intermediate in type between that of the Anomodonts and that of the typical Cynodonts. In *Dicynodon* and allied forms the condyle is single and made up of a median basioccipital portion and two lateral exoccipital parts. Here the basioccipital part has become very much reduced, and the exoccipital parts are approximated. Though there is thus produced a double condyle by the reduction and retreat of the basioccipital, the two condyles are so near that they probably act as a single condyle. In the Cynodonts proper the exoccipital portions become enlarged and separated by a very deep cleft.

The lower jaw is in a very interesting condition. Hitherto one of the most striking distinguishing features of the Cynodonts has been that the dentary extended backwards nearly to the articulation, whereas in the Therocephalians the posterior third of the jaw was formed entirely by the articular, the angular, and the surangular. In *Bauria* we have a condition exactly intermediate between the two types. The dentary is long and not very powerful, and has most probably, like the maxilla, 10 molars. Those which are displayed are like the upper teeth simple and unserrated. The canine is fairly large and perfectly round, and there are four incisors slightly flattened transversely. The complete dental formula of *Bauria* would thus be: $i\,\frac{4}{4}\,c\,\frac{1}{1}\,m\,\frac{10}{10} \times 2 = 60$. The coronoid process is thicker and shorter than in most Therocephalians, and less expanded than in typical Cynodonts. The Cynodonts hitherto known have all differed from the Therocephalians in having the dentary nearly reaching to the articulation. In *Bauria* the dentary only forms the anterior three-quarters of the jaw. The posterior part of the jaw is much more Therocephalian in type than Cynodont. The surangular forms a rounded convex upper border to the hind part, and the angular is of fair size. The articular is also Therocephalian in type.

The atlas vertebra, so far as can be seen, is fairly similar to that in the ordinary Cynodonts and has a large inferior piece. It is apparently the arch mainly that gives articulation to the occipital condyles. The broad inferior piece, though not anchylosed with the arch, must be firmly attached to it by ligaments. There is a proatlas.

The axis has a flat broad odontoid process which lies above the inferior piece of the atlas, and owing to its shape it must have been almost impossible for any rotatory movement to have been made round the odontoid. In this feature *Bauria* is distinctly more

primitive than *Cynognathus* or *Gomphognathus*. Most probably the rotation of the skull was effected round the occipital condyles, and as the condyles became divided and rotation impossible there the odontoid process took up the function.

There is a distinct intercentrum between the axis and the third cervical, and the body of the third cervical is very deeply concave—very possibly notochordal.

I have named this most important genus after the distinguished palæontologist, the late Dr. George Baur, of Chicago University. I had not the good fortune to be acquainted with him, and even now know nothing of him but his work. But it has long seemed to me that the character of that work was such as entitled him to a higher rank among palæontologists than has been generally assigned him. By treating palæontology as a branch of zoology rather than of geology, he has done much to assure that for all future time every palæontologist must be in the first place a zoologist.

Eccasaurus priscus, g. et sp. nov.

The type of this new genus and species is a large humerus, found by Mr. J. L. Cairncross in the Ecca beds about twelve miles N.W. of Prince Albert, and probably near the same horizon as *Archæosuchus cairncrossi*. In giving a name to a humerus I have departed from my almost invariable rule of only making types of skulls or teeth. But as fossils are extremely rare in the Ecca beds, and the gigantic lizard-like form represented by this humerus is not likely to be confused with any other animal, as it is of quite a different type from any previously discovered, I think it well to name it.

It measured 344 mm. in greatest length. The upper end is 179 mm. broad and the lower end 207 mm., and the plane of the upper end makes with the lower an angle of about 25°. In the middle the shaft is constricted, so that its broad diameter measures only 72 mm. About 122 mm. above the lower end is a well-developed entepicondylar foramen. From the outer side there passes forward a fairly well-developed delto-pectoral ridge, whose plane is for the greater part at right angles to the plane of the lower end of the bone. The point of the ridge is situated about 216 mm. from the distal end. Unlike the ridge in the Anomodonts, it is not continued on to the upper end of the bone, ending about 80 mm. short of the head.

Of previously discovered humeri only one, so far as I am aware, agrees with the present type in all essentials, viz., the humerus of

Procolophon. In both, the head is similar in being continued up to a point externally. In *Procolophon* the deltoid ridge is separated from the head and has a very similar structure. The lower end of the bone differs only that in *Procolophon* the outer condyle is pointed and the inner rounded, whereas in the large Ecca type the inner is pointed and the outer rounded. In the Pelycosauria the humerus is somewhat similar but less like than in *Procolophon*.

While it is impossible to say with certainty to which order the new humerus belongs, we may safely affirm that it does not belong to any of the Therapsidan groups, the humerus being well known in the Anomodontia, Therocephalia, Dinocephalia, and Cynodontia, and being of quite a different type. Nor is there any resemblance to the humerus of *Pareiasaurus*. On the other hand, the close resemblance to that of *Procolophon*, and the less-marked affinity with that of other early Diaptosaurian types, seems to indicate that the new genus, which I propose to call *Eccasaurus*, is a primative Diaptosaurian which probably belongs to a distinct and new sub-order.

HELEOPHILUS ACUTUS, g. et sp. nov.

The type of new form is a very fragmentary skeleton found by myself at Victoria West. It consists of a crushed skull with both mandibles, a few very imperfect cervical vertebræ, and a fragmentary foot.

The skull, which measures 28 mm. in length and about 14 mm. in breadth, resembles in general characters, so far as preserved, that of *Heleosaurus scholtzi*. The mandibles are fairly well preserved, portions of the premaxillaries and maxillaries, and crushed fragments of the palate.

The premaxillary appears to have had about 3 teeth, and the maxillary about 15. These are long rounded pointed teeth, which when fully grown become anchylosed to the bone, as in *Procolophon*. When immature they are in sockets. There are no indications of serrations.

The neck is probably a little shorter than the head, but is so badly preserved that it is impossible to clearly define the vertebræ and to say where it ends. The remains of a foot are seen lying a little behind the supposed posterior end of the neck. There are four fairly well preserved metatarsals (supposing the foot to be a posterior one), the 1st measuring 2·7, the 2nd 5·5 apparently, the 3rd 6·7, and the 4th about 7·5. The 5th is only represented by faint indications. The 4th supports 5 slender phalanges. The phalanges of the other

digits are mostly lost. There is a well-developed 1st tarsal, a small 2nd tarsal, and a large 3rd tarsal, while a fair-sized element articulates behind with all three. It will be seen that the general structure of the foot is typically Diaptosaurian and more adapted for land progression than that of *Mesosaurus*.

While it is impossible to be certain of the affinities of *Heleophilus*, we may, I think, safely place it near *Heleosaurus*, from which it differs in having long rounded teeth, and provisionally we may put both in the *Mesosauria*.

When I described *Galechirus* and *Heleosaurus* from Victoria West, I thought it not improbable that we had here evidences of the land forms of the *Lystrosaurus* fauna. Both are distinctly primitive types, the one an ancestral Therocephalian and the other apparently allied to *Mesosaurus*, and it is satisfactory to have the opinion of Mr. A. L. du Toit, who has since visited the locality, that the Victoria West beds are probably very low in the Beaufort series. We are therefore safe in concluding that *Heleophilus* and the others are Permian and probably Lower or Middle Permian.

(9).—*On a Large Extinct Species of Bubalis.*—By R. Broom, D.Sc.

The specimen consists of the postorbital portion of the skull with the proximal part of the left horn core. The right side of the most of the upper surface is missing, but the occiput is nearly complete and much of the base of the cranium is preserved.

The large bony elevation from which the horns spring rises to a height of 75 mm. above the roof of the brain case, and contains two

BUBALIS PRISCUS. × $\frac{1}{5}$.

enormous air sinuses. Taking direction from the basi-cranial axis, the horn core passes backwards and outwards, so that when the skull is viewed from behind the proximal portions of the horns lie in a horizontal line. There is some little evidence that more distally the horn curves slightly upwards. The greatest width of the horn core at its base is 110 mm., and the greatest thickness 63 mm. The frontal region immediately in front of the base of the horn core

measures 146 mm. across. From the upper margin of the foramen magnum to the highest point of the skull is 150 mm. The foramen magnum itself measures at its narrowest part in the neighbourhood of the hypoglossal foramen 32 mm. by 42 mm., while the width across the occipital condyles is 116 mm.

The specimen was discovered by Mr. C. J. de Villiers in the banks of the Modder River, half-way between Kimberley and Bloemfontein.

As it differs from any of the recent species and also apparently from any of the previously known extinct forms, I propose to name it *B. priscus*.

In the outward spread of the horns it resembles more the northern forms, such as *B. cokei* or *B. swaynei*, but differs markedly from both, especially in the greater size and in having much more massive horns. Pomel has recently described two new extinct species from North Africa under the names *Boselaphus probabalis* and *B. ambiguus*. Both of these resemble this South African form more closely than any of the recent species, but both differ in the curve of the horns.

(10).—*On Evidence of a Large Horse recently extinct in South Africa.* —By R. Broom, D.Sc.

About five years ago one of my students brought me a couple of upper molars of a large horse from a superficial deposit in the Karroo, but as they appeared to me to be those of a recent horse, no further notice was taken of them. A couple of years later there was found at Bloembosch, near Darling, a number of remains of a large horse associated with the remains of *Bubalus baini*, and apparently contemporaneous with the Bushmen. The front of the snout was very appreciably larger (about $\frac{1}{5}$) than that of any recent horse of which I could obtain the skull. As, however, the horse remains were manifestly not old geologically, and there seemed just a possibility that they might have belonged to horses of the earlier European settlers, I sent the specimens to Professor H. F. Osborn, who passed them on to Professor W. B. Scott. But as neither of these palæontologists has done anything with the specimens, I assume that, like myself, they felt there was some doubt in the matter.

About 18 months ago a new specimen was discovered, which makes it pretty certain that a very large horse was a native of South Africa before European occupation. Along the western coasts of the Cape Colony the sand hills frequently become converted into limestone by the infiltration of lime. In some places the limestone forms thick beds, but in others it is present as thin layers not more than a few inches thick. In Table Bay and along the coast to the north there is a similar formation of limestone in the sea, as after storms slabs of it are cast up on the shore by the waves. It is doubtful whether this limestone has been formed in the sea, but as in structure it appears identical with that found on the flats, it seems more probable that it has been formed on the land and afterwards submerged. In one of the slabs cast ashore at Yzerplaatz is the greater part of the left lower jaw of a large horse. The 3rd and 4th premolars and the 1st and 2nd molars are fairly well preserved, and the 2nd premolar less satisfactorily. The 2nd premolar probably measures about 30 mm. in length. The 3rd premolar is 33·5 mm.

in length, and the total height of the crown and root, even with the surface considerably worn, is 92 mm. In general pattern it agrees closely with that of modern horses, but differs in its larger size and in showing no trace of the rudimentary protostylid. The fold of enamel which forms the inner wall of the hypolophid measures 18·5 mm. in length. The 4th premolar has its crown fairly well preserved. The hypolophid is very large, and there is no trace of a fold corresponding to the protostylid. The entostylid is small, and the parastylid scarcely extending in front of the metaconid. The total length of the hypolophid and the small entostylid is 20 mm., and the enamel fold on its inner wall is 16 mm. The whole length of the crown is 34 mm., and the height of the crown and root is 105 mm. The 1st and 2nd molars are of equal size, measuring 30 mm. in length and 97 mm. in height.

The length from the front of the grinding surface of pm.[2] to the lower side of the jaw is 110 mm. The whole length of the first five grinding teeth is 158 mm. The six teeth probably measured 198 mm.

The average length of the molar series in *Equus caballus* is 170 to 175 mm. In *Equus hemionus* the series measures about 158 mm. Even in the large *Equus sivalensis* the series measures from 180 to 195. We thus seem justified in concluding that South Africa was until recently the home of a species of horse considerably larger than *Equus caballus*, and though much more would require to be known before it would be possible to say in how far it differed from *Equus caballus*, it seems advisable to give it a distinctive name, and I therefore propose to call it *Equus capensis*.

A year ago Fraas, in a paper, "Pleistocäne Fauna aus den Diamantseifen von Südafrika," described some remains of pleistocene South African mammals, and among them some teeth of a species of *Equus*. Whether this may belong to the same species as the Yzerplaats specimen cannot at present be decided, but it shows that a large horse was contemporaneous with a species of *Mastodon*, and it seems not unlikely that it is the same horse that is contemporaneous with *Bubalus baini* further south.

(11).—*On the Shoulder Girdle of* Cynognathus.—By R. Broom, D.Sc.

In 1895 Seeley described under the name *Cynognathus crateronotus* the magnificent skeleton which now adorns the British Museum. Though the limbs are missing the skull and vertebral column are well preserved, and the resemblance of the skeleton to that of a large carnivorous mammal is so striking as to constantly force on the attention the question as to whether it may not belong to the group from which the mammals sprang. To those of us who believe that the resemblance is not merely superficial, but denotes a close relationship, it seems important that every detail in the organisation of the group should be known as thoroughly as possible.

Though the limbs are unknown in *Cynognathus*, Seeley has thrown considerable light on them from specimens of other Cynodonts, especially *Microgomphodon*, and I have been able to add a few more facts in connection with *Diademedon* and *Ælurosuchus*. Still, there are some points on which nothing is known, and others where our knowledge is very imperfect.

Some months ago I obtained near Burghersdorp on the farm Vaalbank some imperfect remains of a skeleton of a species of *Cynognathus*. The remains consist of a large part of the vertebral column with most of the shoulder girdle and pelvis and parts of both upper and lower limbs. The only fragments of the skull are very imperfect, but it is probable that they belong to *Cynognathus crateronotus* or an allied species, and the scapula agrees very closely with that of the London type. The specimen, though imperfect, is of the greatest value, in that for the first time we obtain precise knowledge of the structure of the shoulder girdle in a Cynodont reptile.

The scapula is already well known from Seeley's specimen; the only point about which there remained any doubt being the lower end. In both the scapulæ of the type there is a distinct acromion process. In that of the right side the bone is seen to be a little narrowed below the process and before expanding to meet the precoracoid. In the case of the left scapula, the anterior margin of the bone has been restored and made considerably too large and thick. In

the present specimen the margin of the bone below the acromion is exactly as in the unrestored type scapula. About 30 mm. below the acromion the scapula is, of course, again greatly expanded to meet the precoracoid.

The coracoid is singularly short, and not more than about 10 mm. is missing from the lower border of the right coracoid in the type specimen.

The precoracoid is also comparatively small. The anterior margin is 22 mm. in front of the foramen, and the lower margin 26 mm. below it.

The clavicle is a short, rather stout bone, which stretches from the acromion process down to middle line, probably meeting its neighbour in front of the interclavicle. The upper end appears to have a broad articulation with the acromion and the 20 mm. or so of the anterior margin of the scapula below it. While the upper end is flattened to fit the border of the scapula the lower end is flattened in the opposite direction to fit the front of the interclavicle.

The interclavicle is not very well preserved, and the posterior portion is missing, but all the important features can be made out. It differs from that of the Monotremes in being in no way T-shaped. It is at least 130 mm. in length, and the broadest part in front measures 63 mm. It is a little narrower in the middle, measuring only 45 mm. wide, but posteriorly it widens out to 60 mm. The lower half is somewhat concave in front.

(12).—*An Attempt to Determine the Horizons of the Fossil Vertebrates of the Karroo.*—By R. Broom, D.Sc.

Recently I made a list of the genera of the fossil vertebrates of the Karroo, and endeavoured to place them in the various horizons. The following is an attempt to review and determine the horizons of the more important species.

In South Africa we have been singularly fortunate in having had most of our types founded on skulls or teeth, so that there is no great burden of synonymy. In the following lists I have almost entirely ignored types founded on vertebræ or fragments of skeletons, as most of these are probably portions of animals already known from the skulls. In many cases it will be long before it will be possible to identify every limb bone, but in the large majority of cases, where new types have been founded on limb bones or other portions of the skeleton than skulls, I have satisfied myself that a mistake has been made in conferring a new name.

	Permian. Dwyka.	Permian. Ecca.	Permian. Pareiasaurus Beds.	Permian. Endothiodon Beds.	Permian. Cistecephalus Beds.	Triassic. Lystrosaurus Beds.	Triassic. Procolophon Beds.	Triassic. Cynognathus Beds.	Triassic. Molteno Beds.	Jurassic. Red Beds.	Jurassic. Cave Sandstone.
PISCES.											
Selachii.											
ORDER PLAGIOSTOMI.											
Hybodus africanus, Broom								×			
Dipnoi.											
ORDER SIRENOIDEI.											
Ceratodus capensis, S.-Woodward								×			
Ceratodus kannemeyeri, Seeley										×	
Ceratodus ornatus, Broom								×			
Ganoidei.											
ORDER CROSSOPTERYGII.											
Cœlacanthus africanus, Broom								×			
ORDER HETEROCERCI.											
Helichthys browni, Broom								×			
Helichthys draperi (S.-Woodward)								×			
Helichthys tenuis, Broom								×			
Elonichthys, sp.	×										
Elonichthys, sp.		?	×								
Atherstonia scutata, S.-Woodward						×					
Atherstonia minor, S.-Woodward						?					
Atherstonia seeleyi, S.-Woodward						?					
Acrolepis molyneuxi, S.-Woodward				?							
Acrolepis (?) digitata, S.-Woodward				?							
Oxygnathus browni, Broom								×			
Dictyopyge formosa, Broom								×			
ORDER LEPIDOSTEI.											
Semionotus capensis, S.-Woodward											×
Cleithrolepis extoni, S.-Woodward								×			
Cleithrolepis minor, Broom								×			
Hydropessum kannemeyeri, Broom								×			
Pholidophorus africanus, Broom								×			
AMPHIBIA.											
ORDER STEGOCEPHALIA.											
Rhinesuchus whaitsi, Broom			×								
Rhinesuchus africanus (Lydekker)			?								
Cyclotosaurus albertyni, Broom								×			
Capitosaurus africanus, Broom								×			
Trematosaurus kannemeyeri, Broom								×			
Batrachosuchus browni, Broom								×			
Rhytidosteus capensis, Owen								?			
Bothriceps major (Owen)								?			
Bothriceps huxleyi, Lydekker								?			
Micropholis stowi, Huxley							?				
Micropholis granulata (Owen)							×				

	Permian.					Triassic.				Jurassic.	
	Dwyka.	Ecca.	Pareiasaurus Beds.	Endothiodon Beds.	Cistecephalus Beds.	Lystrosaurus Beds.	Procolophon Beds.	Cynognathus Beds.	Molteno Beds.	Red Beds.	Cave Sandstone.
REPTILIA.											
Super-order COTYLOSAURIA.											
Order PAREIASAURIA.											
Pareiasaurus serrideus, Owen			×								
Pareiasaurus baini, Seeley			×								
Propappus omocratus, Lydekker				×							
Tapinocephalus atherstonei, Owen			×								
Super-order THERAPSIDA.											
Order DROMASAURIA.											
Galechirus scholtzi, Broom			?								
Order DINOCEPHALIA.											
Delphinognathus conocephalus, Seeley			×								
Titanosuchus ferox, Owen			×								
Titanosuchus clœtei, Broom			×								
Archæosuchus cairncrossi, Broom		×									
Scapanodon duplessisi, Broom			×								
Order THEROCEPHALIA.											
Alopecodon priscus, Broom			×								
Alopecodon rugosus, Broom			×								
Scylacosaurus sclateri, Broom			?								
Pristerognathus polyodon, Seeley				?							
Pristerognathus baini, Broom				?							
Pardosuchus whaitsi, Broom			×								
Scymnosaurus ferox, Broom			×								
Scymnosaurus warreni, Broom			?								
Glanosuchus macrops, Broom			×								
Ictidosaurus augusticeps, Broom			?								
Ælurosaurus felinus, Owen			?								
Gorgonops torvus, Owen			?								
Scaloposaurus constrictus, Owen				?							
Arnognathus parvidens, Broom			×								
Trochosaurus acutus, Broom			×								
Hyænasuchus whaitsi, Broom			×								
Lycosuchus mackayi, Broom				?							
Lycosuchus vanderrieti, Broom				?							
Ictidosuchus primævus, Broom				×							
Cynosuchus suppostus, Owen					?						
Cynodraco serridens, Owen				×							
Tigrisuchus simus, Owen					?						
Lycosaurus pardalis, Owen				?							
Lycosaurus tigrinus, Owen				?							
Lycosaurus curvimola, Owen				?							
Cynochampsa laniaria, Owen				?							
Order ANOMODONTIA.											
Endothiodon bathystoma, Owen				×							

	Permian.					Triassic.				Jurassic.	
	Dwyka.	Ecca.	Pareiasaurus Beds.	Endothiodon Beds.	Cistecephalus Beds.	Lystrosaurus Beds.	Procolophon Beds.	Cynognathus Beds.	Molteno Beds.	Red Beds.	Cave Sandstone.
Esoterodon uniseries (Owen)				×							
Cryptocynodon simus, Seeley				?							
Prodicynodon pearstonensis, Broom				×							
Opisthoctenodon agilis, Broom				×							
Opisthoctenodon brachyops, Broom				?							
Pristerodon mackayi, Huxley				?							
Chelyoposaurus williamsi, Broom				?							
Dicynodon lacerticeps, Owen						?					
Dicynodon leoniceps, Owen				?							
Dicynodon feliceps, Owen				?							
Dicynodon pardiceps, Owen					?						
Dicynodon simocephalus, Weithofer								?			
Dicynodon latifrons, Broom								?			
Dicynodon ingens, Broom								?			
Dicynodon testudiceps, Owen			?								
Dicynodon tigriceps, Owen				×							
Dicynodon jouberti, Broom			×								
Oudenodon baini, Owen				×							
Oudenodon strigiceps, Owen					?						
Oudenodon megalops, Owen					?						
Oudenodon prognathus, Owen				?							
Oudenodon greyi, Owen				×							
Oudenodon gracilis, Broom				×							
Oudenodon trigoniceps, Broom				×							
Oudenodon megalorhinus, Broom			×								
Oudenodon, sp.								×			
Lystrosaurus declivis (Owen)						?					
Lystrosaurus latirostris (Owen)						×					
Lystrosaurus microtrema (Seeley)						?					
Lystrosaurus murrayi (Huxley)						×					
Lystrosaurus boops (Owen)						×					
Lystrosaurus frontalis, Cope						?					
Lystrosaurus m'caigi (Seeley)						×					
Lystrosaurus platyceps (Seeley)						×					
Lystrosaurus andersoni, Broom						?					
Cistecephalus microrhinus, Owen					×						
Cistecephalus leptorhinus, Owen					×						
Cistecephalus planiceps, Owen					×						
Order CYNODONTIA.											
Bauria cynops, Broom								×			
Galesaurus planiceps, Owen								×			
Cynognathus crateronotus, Seeley								×			
Cynognathus platyceps, Seeley								×			
Cynognathus berryi, Seeley								×			
Ælurosuchus browni, Broom								×			
Gomphognathus kannemeyeri, Seeley								×			
Gomphognathus polyphagus, Seeley								×			

	Permian.					Triassic.				Jurassic.	
	Dwyka.	Ecca.	Pareiasaurus Beds.	Endothiodon Beds.	Cistecephalus Beds.	Lystrosaurus Beds.	Procolophon Beds.	Cynognathus Beds.	Molteno Beds.	Red Beds.	Cave Sandstone.
Diademodon mastacus, Seeley								×			
Diademodon tetragonus, Seeley								×			
Trirachodon kannemeyri, Seeley								×			
Trirachodon berryi, Seeley								×			
Trirachodon minor, Broom								×			
Microgomphodon oligocynus, Seeley								×			
Sesamodon browni, Broom								×			
Melinodon simus, Broom								×			
Tribolodon frerensis, Seeley								×			
Super-order DIAPSIDA.											
Order PROCOLOPHONIA.											
Procolophon trigoniceps, Owen							×				
Procolophon baini, Broom						?					
Thelegnathus browni, Broom								×			
Thelegnathus parvus, Broom								×			
Saurosternon baini, Huxley				×	?						
Order MESOSAURIA.											
Mesosaurus tenuidens, Gervais	×										
Mesosaurus pleurogaster, Seeley	×										
Mesosaurus capensis (Gürich)	×										
Heleosaurus scholtzi, Broom			?								
Heleophilus acutus, Broom			?								
Eunotosaurus africanus, Seeley			×								
Order PROTEROSUCHIA.											
Proterosuchus fergusi, Broom							×				
Order GNATHODONTIA.											
Howesia browni, Broom								×			
Order RHYNCHOCEPHALIA.											
Palacrodon browni, Broom								×			
Order PHYTOSAURIA.											
Erythrosuchus africanus, Broom								×			
Order LACERTILIA.											
Paliguana whitei, Broom							×				
Order CROCODILIA.											
Notochampsa longipes, Broom										×	
Notochampsa istedana, Broom											×
Order DIOSAURINA.											
Massospondylus carinatus, Owen										×	
Thecodontosaurus skiropodus (Seeley)										×	×
Thecodontosaurus browni (Seeley)										×	
Euskelesaurus browni, Huxley										×	
Order unknown											
Pelosuchus priscus, Broom			×								
Eccasaurus priscus, Broom		×									
MAMMALIA.											
Order MULTITUBERCOLATA.											
Tritylodon longæous, Owen										?	
Karoomys browni, Broom								×			

13.—*On the Dinosaurs of the Stormberg, South Africa.*—By R. Broom, M.D., D.Sc., C.M.Z.S.

(Plates XIV.-XVII.)

Though the first South African Dinosaurs were discovered nearly sixty years ago, only a very few forms have hitherto been described, and these from very fragmentary remains.

Massospondylus carinatus, Owen.

In 1853 Mr. J. M. Orpen, Government Surveyor, discovered on the farm Beaucherf, Harrismith, a series of fairly large bones, and on the Harrismith commonage some smaller bones. These he forwarded to his father, the Rev. C. E. H. Orpen, of Colesberg, who transmitted them to Professor Owen. Owen apparently believed that all the bones came from one spot, and regarded them as belonging to these different genera and species which he named *Massospondylus carinatus*, *Pachyspondylus Orpenii*, and *Leptospondylus capensis*. No figures were given by Owen, but in 1895 Seeley redescribed and figured the principal remains, and regarded ali as probably belonging to one species. Huene has recently very fully described and figured all the specimens, and agrees with Seeley that all belong to one species, but recognises a larger and a smaller individual. Mr. J. M. Orpen has recently given me particulars of the finds, and it is quite evident that there are two individuals represented, and probably only two. Unfortunately the remains of the smaller individual are very unsatisfactory, and Owen's genera *Pachyspondylus* and *Leptospondylus* are founded on vertebræ so imperfect that it is doubtful if either can be regarded as satisfactory types even if distinct from *Massospondylus*, and it is pretty certain one at least is founded on remains of *Massospondylus carinatus*. The small individual possibly belongs to the species I am describing as *M. harriesi*.

EUSKELESAURUS BROWNI, Huxley.

ORINOSAURUS CAPENSIS, Lydekker.

Never was there a man with a greater genius for collecting than Mr. Alfred Brown, of Aliwal North, and though Aliwal is by no means a rich district, his perseverance during over fifty years has been rewarded by the discovery of a large number of most interesting remains. But valuable as his work has been, we who know the man have some idea of what he would have done had he received more encouragement.

When he discovered the large bones of *Euskelesaurus* he spent a very considerable sum in excavating and having them sent to England. The first consignment was sent to Sir R. Murchison, who handed them over to Huxley for description. Huxley recognised the remains as those of huge Dinosaurs, and named the principal form *Euskelesaurus browni.* A large crushed tibia he described as *Orosaurus.* A second consignment was sent to Murchison, and the receipt of it duly acknowledged, but this lot of bones was apparently lost. Brown sent his next consignment to Paris, where it was described and figured by Fischer. A still later collection was sent to Vienna. Mr. Brown informs me that all these collections were got at the same spot, so that while it is manifest that they are the remains of two individuals, it is probable that the Vienna remains are parts of the type of *Euskelesaurus browni.* He further informs me that the collection which has been lost "contained chiefly the remains of large limbs and other massive bones."

Seeley, in 1894, redescribed and figured all the principal remains of *Euskelesaurus*, including a further number of bones that had been obtained by Mr. Brown. In addition, he describes a lower jaw and cervical vertebra obtained at Kraai River which are doubtfully referred to *Euskelesaurus browni.* In 1905 Mr. Brown sent to the South African Museum some further remains from Kraai River, also believed to be *Euskelesaurus*, but when the remains were developed it was found that they belonged to a new animal which was not even a Dinosaur. This new type I named *Erythrosuchus africanus.* When the collection of fossils given by Dr. Kannemeyer to Professor Seeley was worked up, it was found to contain much of the skeleton of another specimen of *Erythrosuchus*, including the greater part of the skull, and when the mandible was compared with that supposed to be of *Euskelesaurus*, the two were seen to be practically similar. There is thus no doubt that the mandible figured by Seeley is really

the mandible of *Erythrosuchus* and not that of *Euskelesaurus*. And there is reason to suppose that the short cervical vertebra is also that of *Erythrosuchus*.

Orosaurus of Huxley was changed to *Orinosaurus* by Lydekker, and the specific name *capensis* added. Huene has fully re-examined all the *Euskelesaurus* remains, and gives a restoration of the animal. He regards *Orinosaurus capensis* as but another species of *Euskelesaurus*.

Hortalotarsus skirtopodus, Seeley.

Massospondylus browni, Seeley.

Hortalotarsus skirtopodus is founded on a fragment of the hind limb of a small Dinosaur from Barkly East. Originally most of the skeleton was in the rock, and it was regarded by the farmers as the skeleton of a Bushman, but it is said to have been destroyed through fear that a Bushman skeleton in the rock might tend to weaken the religious belief of the rising generation. Huene is of opinion that *H. skirtopodus* really belongs to the European genus *Thecodontosaurus*.

In 1905 I described the hind limb, with pelvis and some vertebræ of a specimen which I thought might be referred to *Hortalotarsus skirtopodus*, thinking the differences in size might be due to this specimen being immature. If, however, Huene is right in regarding *H. skirtopodus* as really a species of *Thecodontosaurus*, and there is little doubt that *Hortalotarsus* is at least allied to *Thecodontosaurus*, then the South African Museum specimen which I referred to *Hortalotarsus* must be placed in a new genus.

Massospondylus browni is, like *Hortalotarsus skirtopodus*, only known from a few remains. The femur, however, is well preserved, and seems to show that the species belongs to *Thecodontosaurus*, as is maintained by von Huene.

Gyposaurus capensis, g. et sp. nov.

This new genus and species is founded on the South African Museum specimen which I had referred to *Hortalotarsus skirtopodus*. The two animals are of practically the same size, but the pelvis and femur of the South African Museum specimen are very different from those of *Thecodontosaurus*, and must belong to a new genus.

Among the chief characteristics of this new genus the most noteworthy is the remarkable shape of the ilium. The iliac crest has a greater anterior extension than in any other known carnivorous

Dinosaur, and the preacetubular process relatively small. The femur is relatively stout, and has the *trochanter quartus* small and high up, and the *trochanter major* almost rudimentary.

All the remains of any importance are figured in a paper in the Trans. South African Phil. Soc., vol. xvi., pt. 3, 1906.

Gryponyx africanus, g. et sp. nov.

Recently there was discovered on the farm of Mr. J. L. Harries, Foutani, near Fouriesburg, in the Orange Free State, a considerable number of remains of Dinosaurs, and the more accessible have been excavated by Mr. A. R. Walker, of the South African Museum, with Mr. Harries' assistance. All the remains are from the Red beds.

The most important is a large carnivorous Dinosaur allied to *Plateosaurus* of Europe, but apparently belonging to a new genus and species which I have named as above. The anterior half of the animal has been lost, but Mr. Walker and Mr. Harries were successful in obtaining both the right and left manus, most of the dorsal vertebræ, the whole pelvis, both hind limbs, and the right pes. The greater part of the tail had to be left in the rock, as, owing to its passing straight into the cliff, it could not have been all removed except at very great expense.

The vertebræ have not yet been completely developed, but so far as can be seen they appear to agree fairly closely with those of *Plateosaurus*.

The radius and ulna are both well preserved in their distal halves, but imperfect proximally. The shapes of the distal ends are seen in the figures.

In the carpus there are seven elements, and though there is some doubt concerning the determination of one or two, most can be determined with certainty and the others with much probability. The 1st, 2nd, and 3rd distal carpalia are in undisturbed relations with the metacarpals, and there can be practically no doubt about them. All the proximal carpals are small, and in the specimen three lie below the end of the radius. These I believe to have been displaced and to be the radiale, the intermedium, and the ulnare. While this seems to be the natural determination of the three proximal elements, it is confirmed by the fact that they can be fitted in their natural position on the proximal side of the distal carpalia. The 7th element is small, and from its situation by the side of the 3rd carpale it is evidently the 4th carpale.

Assuming these determinations to be correct the elements may be described as follows:—

Radiale.—A very small lenticular bone measuring 10 mm. in length and about 4 mm. in greatest thickness. It has probably been imbedded in cartilage, and lay in a concavity on the upper side of the inner half of the large 1st distal carpale.

Intermedium.—A moderate-sized bone, which appears to have lain on the proximal side of the outer fourth of the 1st carpale.

Ulnare.—This is roughly about the same size as the intermedium. The outer and under side is concave as if to fit a part of the cartilage of the 4th carpale. It appears to have articulated with the 2nd and 3rd carpalia.

1st carpale.—This is a very large bone which distally articulates with most of the end of the large 1st metacarpal and with half of the proximal end of the 2nd carpale. Proximally it articulates with the largely cartilaginous radiale and the intermedium. It seems, however, pretty certain that the lower half of the proximal end articulated with the radius when the hand was flexed. The greatest length of the bone is 56 mm., and the greatest thickness between the dorsal and ventral sides about 35 mm. Between the proximal and distal surfaces the greatest measurement is 20 mm.

2nd carpale.—This is a little less than half the size of the 1st carpale. On the dorsal side it is narrow, and fits in between the 1st carpale and the end of the 2nd metacarpal, but on the palmar surface it is broad and underlies a part of the metacarpal.

3rd carpale.—This appears on the dorsal surface larger than the 2nd, but on the palmar surface rather smaller. On the ulnar and proximal side there is a small concavity which probably articulated with the large and mainly cartilaginous 4th carpale.

4th carpale is a small flattened spheroidal bone about 12 mm. in length and 7 mm. thick. It was probably imbedded in a large amount of cartilage.

The 1st metacarpal is a large bone, measuring in greatest length 64 mm. and about 54 mm. in width. The distal articular end is divided into a large portion on the ulnar side and a small portion on the radial. The 1st phalanx of the 1st digit has a very broad proximal end measuring about 47 mm. Distally there is a bilobed articulation for the large claw, which is so arranged that the claw must have pointed downwards and towards the radial side. The length of the bone is 63 mm. The 2nd phalanx is the huge claw of the pollex. The proximal end measures 52 mm. in depth and about 28 mm. in greatest width. There is a very large bony process for

the insertion of the flexor tendon. The curve on the upper side of the claw is part of a circle with a radius of about 60 mm. On the radial side is a marked vascular groove, which runs nearly to the point. The claw appears to have been able to move on the phalanx through about 60°. The greatest length is about 105 mm.

The 2nd metacarpal measures 80 mm. in length, and 39 mm. in breadth at its proximal end and 35 mm. at its distal. It articulates proximally with the small 2nd carpale. The upper side of the distal end has the articular surface extending back for 20 mm., so that the 1st phalanx could have been bent back to about 75°.

The 1st phalanx is a short powerful bone measuring 42 mm. in length. At the proximal end it measures 30 mm. in width and 28 mm. in depth. The distal end measures 28 mm. in width and 20 mm. deep.

The 2nd phalanx measures 35 mm. in length. The proximal end is 25 mm. by 25 mm., and the distal 23 mm. by 20 mm.

The terminal phalanx probably measured 65 mm. in length and the proximal end 20 mm. by 32 mm.

The 3rd digit is rather more slender than the 2nd. The metacarpal is 75 mm. long. The proximal end is 38 mm. wide, and the distal end 30 mm. The articular surface on the distal end does not extend down the upper surface as in the 2nd metacarpal, and the 1st phalanx could probably not bend back more than 25°, nor could it have been flexed more than 30°.

The following are the measurements of the phalanges of the 3rd digit:—

	Length.	Proximal Width.	Proximal Depth.	Distal Width.	Distal Depth.
1st phalanx	32 mm.	24 mm.	18 mm.	22 mm.	13 mm.
2nd phalanx	25 ,,	20 ,,	18 ,,	18 ,,	13 ,,
3rd phalanx	24 ,,	17 ,,	17 ,,	16 ,,	13 ,,
Claw phalanx ...	43 ,,	14 ,,	20	—	—

In the 3rd digit very little extension beyond the straight was possible, and the amount of flexion was limited to about 45° in the case of the claw, and about 30° in the case of the phalanges.

In the best-preserved foot the 4th and 5th digits seem to have been affected with arthritis, and the phalanges are deformed. In this left foot the 4th digit has only one phalanx and the 5th two. In the right foot the 3rd digit has evidently had the toe cut off beyond the 1st phalanx, as it alone remains, and the distal articular

surface has been completely destroyed. The 4th digit is apparently complete and uninjured, but has only three phalanges, and the last is rudimentary and had no claw. The 5th digit in both feet has only two phalanges.

The digital formula for the manus would thus be 2, 3, 4, 3, 2.

The following are the measurements of the bones of the 4th and 5th digits—the former taken from the left and the latter from the right foot :—

	Length.	Proximal Width.	Proximal Depth.	Distal Width.	Distal Depth.
4th metacarpal ...	50 mm.	35 mm.	— mm.	26 mm.	— mm.
1st phalanx	25 ,,	20 ,,	17 ,,	18 ,,	11 ,,
2nd phalanx	19 ,,	15 ,,	12 ,,	13 ,,	7 ,,
3rd phalanx	rudimentary.				
5th metacarpal ...	38 mm.	34 ,,	— ,,	26 ,,	—
1st phalanx	26 ,,	23 ,,	18 ,,	17 ,,	10 ,,
2nd phalanx	rudimentary.				

The pelvis is fairly well preserved, but a little distorted. The pubes and ischia of both sides are complete, and the greater part of both ilia are present. In fact, the only part that requires to be restored is the tip of the anterior process of the iliac crest. The right ilium has the base of the anterior process preserved, and the left ilium the greater part of the iliac crest; so that the small missing part can be restored with much probability.

The iliac crest is much straighter than in *Plateosaurus* or *Teratosaurus*, and the anterior iliac spine is unusually small. The acetabulum is large, and the portions of the ilium which form both its anterior and posterior walls are well developed.

The pubes and the ischia form a complete symphysis, with no opening of any sort in it from the front of the pubis to the posterior end of the ischium. The upper end of the pubis is large and fairly flat and forms a wide angle with its neighbour. It has a large nearly round pubic foramen. The anterior portion of the pubis is broad and flat, the two together at their narrowest part measuring 122 mm. across. The greatest length of the pubis 435 mm.

The ischium is rather shorter than the pubis. In general shape it fairly resembles that of *Sellosaurus* and *Plateosaurus*. Its anterior part has a long articulation with the pubis extending from the acetabulum to the symphysis. The greatest length of the ischium is 405 mm. The greatest measurement across the two ischia where

they meet the ilia is 185 mm., and the narrowest measurement across the two bones near the middle of the posterior portion is 50 mm.

Both femora are nearly completely preserved, but both are much crushed and in opposite ways. The femur resembles pretty closely that of *Plateosaurus*, differing so far as can be seen only in the trochanter minor being smaller and in the third trochanter being more to the inner side of the bone. The one femur measures 535 mm. in length and the other 550 mm.

The tibia has a larger head than appears to be the case in *Plateosaurus*, but otherwise presents no specially interesting features. The total length of the bone is 447 mm., and the proximal end measures 163 mm. by 71 mm.

The fibula is a long slender bone, which is slightly expanded at its distal end and much flattened out at its proximal end. It measures 413 mm. in length.

The tarsus is not well preserved. The tibiale is of the usual shape and has been pretty closely united to the tibia.

The pes is complete, but some of the bones are slightly crushed.

The 1st metatarsal is a rather flat oblong bone. The upper end fits into a hollow on the inner side of the 2nd metatarsal. The greatest breadth of the proximal end is 59 mm. and the greatest thickness 21 mm. The total length of the bone is 112 mm. The distal end is somewhat oblique. It measures in greatest breadth 60 mm. and in greatest thickness 26 mm.

The 2nd metatarsal has an irregular quadrangular proximal end. The breadth across the plantar surface is 50 mm. and across the dorsal probably 30 mm. The depth of the proximal end is across the most remote angles about 74 mm. The greatest length of the bone is 187 mm. The distal end measures in greatest breadth 64 mm.

The 3rd metatarsal has a narrow irregularly triangular proximal end measuring about 40 mm. by 62 mm. The total length measures 203 mm. The distal end measures 50 mm. across.

The 4th metatarsal is much flattened. The proximal end measures 78 mm. across by about 36 mm. deep. The length of the bone is 166 mm. and the distal end measures 52 mm. in breadth.

The 5th metatarsal is a short irregular triangular bone. The proximal end measures 66 mm. in breadth, and total length of the bone is 113 mm.

The following are the measurements of the phalanges :—

			Length.	Proximal Width.	Distal Width.
1st digit	1st phalanx.........		71 mm.	43 mm.	38 mm.
	2nd phalanx.........	about	110 ,,	34 ,,	—
2nd digit	1st phalanx.........		72 ,,	42 ,,	40 ,,
	2nd phalanx.........		53 ,,	37 ,,	35 ,,
	3rd phalanx.........	about	99 ,,	26 ,,	—
3rd digit	1st phalanx.........		71 ,,	53 ,,	38 ,,
	2nd phalanx.........		52 ,,	40 ,,	31 ,,
	3rd phalanx.........		45 ,,	35 ,,	28 ,,
	4th phalanx.........	about	77 ,,	30 ,,	—
4th digit	1st phalanx.........		57 ,,	41 ,,	35 ,,
	2nd phalanx.........		44 ,,	35 ,,	28 ,,
	3rd phalanx.........		38 ,,	30 ,,	25 ,,
	4th phalanx.........		34 ,,	29 ,,	25 ,,
	5th phalanx.........	about	68 ,,	24 ,,	—
5th digit	1st phalanx.........	rudimentary.			

Perhaps the most interesting point in connection with the phalanges is the fact that the claw of the 2nd digit has got a sharp outer side and a rounded inner side. This same condition is found in *Massospondylus harriesi* and *Ætonyx palustris.* There seems to be little doubt that the digit had a claw with a combing or scraping edge such as is seen in many birds, and the question arises, What had the Dinosaur to comb? We seem justified in concluding that the dermal covering was probably of a different nature from the scales seen in lizards and crocodiles. As the combing claw is only on the 2nd digit it had clearly nothing to do with scraping the ground or digging, and from analogy with the bird and marsupials almost certainly was used for cleaning the skin and scales. Probably the skin had elongated scales with soft skin between. This would admit of greater freedom of movement and, like the feathers of birds, would require to be cleaned after the animals had been hunting their prey on the muddy banks of the lakes.

Massospondylus harriesi, sp. nov.

This Dinosaur, which was also discovered on the farm of Mr. Harries, resembles *Massospondylus carinatus* sufficiently closely to suggest the advisability of placing it at least provisionally in the same genus. The remains consist of an imperfect humerus, a nearly perfect radius and ulna, and a perfect manus, as well as portions of the femur and tibia, and a number of toe bones all of one individual, and the perfect pes of another individual.

The humerus has lost the upper third, but the lower two-thirds, including delto-pectoral ridge, is perfect. In general shape it resembles considerably the humerus of *Plateosaurus reinigeri*, but is only about half the size. The narrow part of the shaft is relatively a little thicker in the present species, the lower end of the bone is broader and the delto-pectoral ridge is narrower, and is more directly continuous with the head of the bone. The following are some of the principal measurements :—

Probable greatest length	220 mm.
Breadth at distal end	77 ,,
Width at narrowest part of shaft	32·5 ,,
Width at top of pectoral ridge.........................	72 ,,
From lower end of pectoral ridge to furthest part of distal end	125 ,,

The left ulna is almost perfect, only a small portion of the proximal end being lost, and the left radius is even better preserved. This is the more satisfactory in that in *Massospondylus carinatus* neither the radius nor ulna is known, and in the other Triassic Dinosaurs the bones of the forearm are rarely well preserved. In *Pachysaurus ajax* both radius and ulna are known, but they are considerably distorted. In *Plateosaurus quenstedti* they are better preserved. In *Massospondylus harriesi* the radius is nearly straight, slightly broadening at the upper and lower ends. The upper end has a deep concavity for the condyle of the humerus. On the posterior and inner side of the upper third is an oblique groove, probably for the attachment of the biceps or humero-antibrachialis. The lower end of the bone is curved outwards a little, and the large articular surface looks somewhat forwards.

The ulna is in its upper half nearly twice as broad as the radius. The lower end has the same peculiar twist already seen in *Gryponyx*, but here it is more marked. The distal fourth of the bone is rotated about 40° to the right.

The following are the principal measurements of the bones :—

Greatest length of radius	probably 128 mm.
Width at proximal end	35 ,,
Width at distal end	31 ,,
Width in middle of shaft	19 ,,
Greatest length of ulna	probably 134 ,,
Width at proximal end	57 ,,
Width at distal end	41 ,,
Width in narrowest part of shaft......................	25 ,,

The carpus is imperfect and the rudimentary phalanx of the 5th digit lost, but otherwise the whole of the left manus is perfect, and the bones are so well preserved that it is possible to fit all the bones in true position so that a better idea of the shape of the hand can be obtained than in any other known specimen.

The 1st carpale is concavo-convex in front, like the saddle-shaped end of the centrum of the vertebra of a bird, and convex behind. It measures 36 mm. by 24 mm.

The 2nd carpale is a curved bone with a sharp upper end and a broad square lower end. It fits in between the 1st metacarpal, the 1st carpale, and the 3rd carpale. Its greatest depth is 24 mm., and the lower end measures 13 mm. by 13 mm.

The 1st metacarpal is short and broad, and is remarkable for the very small size of the inner distal condyle. The greatest length is 39 mm. and the proximal breadth 36 mm.

The 1st phalanx of the 1st digit measures, greatest length 42 mm., proximal breadth 31 mm., distal breadth 27 mm. It is much less twisted than in *Gryponyx*, so that when the digit is flexed the claw passes nearly directly downwards. When extended, however, the claw is directed about 45° inwards. The claw measures 72 mm. in length, and the proximal end measures 38 mm. by 21 mm.

The measurements of the other metacarpals and phalanges are as follows :—

	Greatest Length.	Proximal Width.	Distal Width.
2nd metacarpal	49 mm.	32 mm.	27 mm.
1st phalanx	28 ,,	23 ,,	19 ,,
2nd phalanx	22 ,,	17 ,,	15 ,,
Ungual phalanx ...	45 ,,	proximal end	22×13
3rd metacarpal	45 ,,	28 mm.	19 mm.
1st phalanx	18 ,,	16 ,,	13 ,,
2nd phalanx	16 ,,	14 ,,	13 ,,
3rd phalanx	15 ,,	12 ,,	11 ,,
Ungual phalanx ...	27 ,,	proximal end	13×10
4th metacarpal	37 ,,	21 mm.	13 mm.
1st phalanx	15 ,,	11 ,,	9 ,,
2nd phalanx	10 ,,	8 ,,	6 ,,
3rd phalanx	10 ,,	6 ,,	—
5th metacarpal	29 ,,	22 ,,	17 ,,
1st phalanx	16 ,,	14 ,,	11 ,,
2nd phalanx	rudimentary, lost.		

From the structure of the manus it is quite manifest that it could rest on the ground and support the weight of the body. In my opinion the foot did not rest, as believed by von Huene, on the palm, but was quite as digitigrade as the hind foot. My reasons for this conclusion are that it is impossible to fit the metacarpals together satisfactorily so that they could lie on a flat surface, whereas if they are arranged in digitigrade fashion they fit accurately, the ends resting on one plane.

When the foot is placed on the ground the 1st large digit probably bears none of the weight, though possibly the side of the toe may touch the ground. The large claw curves inwards, and may also touch the ground, though it bears none of the weight. The balls of the 2nd, 3rd, 4th, and 5th toes, with probably a palmar pad and the short 4th and 5th digits carry all the weight. The 2nd digit is doubtless considerably extended, so that it makes an angle of about 80° with the metacarpal, and the claw is flexed so that it may just touch the ground. The 3rd digit is less extended, and probably to a considerable extent rests on the ground. The penultimate phalanx is more extended and the short claw flexed. The 4th digit has no claw and rests flat on the ground. The short 5th digit, which has a stout proximal phalanx and probably a single rudimentary distal one, also rests on the ground.

When the animal is standing on its hind feet the digits are probably more flexed, and when catching its prey all three claws can be brought to work together by flexion, but for satisfactory prehension it is necessary for the two hands to work together. Probably the animal caught its prey with its hands and killed and tore it up by blows from one or other of the hind feet.

The femur is imperfect, all the portion above the lower trochanter being lost. The lower half is considerably stouter in relation to its length than in either *Gryponyx*, *Massospondylus carinatus*, or *Plateosaurus*. It is, as preserved, somewhat distorted, but the measurements are as follows:—

Distal end to lower end of trochanter	155 mm.
Width of distal end as crushed	114 ,,
Probable width of uncrushed	90 ,,
Greatest width of narrowest part of shaft	45 ,,

The proximal end of the left tibia is preserved in good condition It measures 102 mm. by 52 mm.

The whole of the pes except the tarsal elements is known in perfect condition, though probably the metatarsals are slightly crushed proximally.

The 1st metatarsal is 87 mm. in length, the proximal end is 40 mm., and the distal end 36 mm. wide. The upper end fits into a deep concavity on the inner side of the 2nd metatarsal.

The 2nd metatarsal has the proximal end irregularly quadrangular, with the one diagonal considerably longer than the other. The greatest width is 63 mm. The greatest length is 138 mm., and the distal end measures 39 mm. across.

The 3rd metatarsal has the proximal end irregularly triangular. The greatest measurement across the upper end is 45 mm. The total length of the bone is 154 mm., and the distal end measures 38 mm. in width.

The 4th metatarsal has the head greatly flattened—partly, perhaps, increased by crushing. The greatest length of this end is 55 mm. The total length of the bone is 135 mm., and the width of the distal end is 31 mm.

The 5th metatarsal measures 75 mm. in length. The proximal end is 44 mm. and the distal end 18 mm. across.

On the whole there is much resemblance between the metatarsals of *Massospondylus harriesi* and those of *Teratosaurus trossingensis*, though the latter is about twice as large.

The following are the principal measurements of the phalanges :—

		Length.	Proximal Breadth.	Distal Breadth.
1st digit	1st phalanx.........	45 mm.	32 mm.	25 mm.
	Claw..................	about 68 ,,	21 ,,	— ,,
2nd digit	1st phalanx...... ..	48 ,,	35 ,,	35 ,,
	2nd phalanx.........	35 ,,	32 ,,	27 ,,
	Claw..................	62 ,,	24 ,,	—
3rd digit	1st phalanx.........	48 ,,	38 ,,	33 ,,
	2nd phalanx.........	35 ,,	30 ,,	27 ,,
	3rd phalanx.........	27 ,,	28 ,,	23 ,,
	Claw..................	51 ,,	23 ,,	—
4th digit	1st phalanx.........	42 ,,	31 ,,	27 ,,
	2nd phalanx.........	30 ,,	25 ,,	24 ,,
	3rd phalanx.........	25 ,,	23 ,,	21 ,,
	4th phalanx.........	22 ,,	19 ,,	19 ,,
	Claw..................	48 ,,	17 ,,	—
5th digit	1st phalanx.........	17 ,,	17 ,,	—

Ætonyx palustris, g. et sp. nov.

In the collection made by Mr. Walker are the remains of a third species of carnivorous Dinosaur much smaller than either of the other two species, and differing from both considerably in the proportions of the limbs. There are preserved the following bones: A few imperfect dorsal vertebræ, a good scapula and coracoid, a good humerus, a good radius and imperfect ulna, the greater part of each manus, the upper end of one tibia, and the almost complete right pes.

The dorsal vertebra agrees in most respects with those of other carnivorous Dinosaurs. The centrum is much flattened and agrees closely with that of *Cœlophysis*, and apparently with *Anchisaurus*. It measures in length 45 mm., and in its narrowest middle part 11 mm. across. The greatest depth of the articular end is 30 mm. The length from the one zygapophysis to the other is about 57 mm., and the measurement from the one transverse process to the other about 37 mm.

The scapula is well preserved, only a very little being lost from its upper end. In general shape the bone resembles that of *Massospondylus* more than that of any other known type. The lower end is very broad, being nearly three times as broad as the middle of the bone is narrow. As preserved the scapula measures 185 mm. in length, and possibly originally measured 210 mm. The width of the narrowest part of the bone is 30 mm. and the width of the lower end 87 mm.

The coracoid is almost perfect. It measures antero-posteriorly 102 mm. and in depth at the region of the foramen 58 mm.

The humerus is perfect except for a small fragment missing from both ends. It agrees pretty closely with the Plateosaurian type, but has the part below the delto-pectoral crest relatively rather shorter. The greatest length of the humerus is 174 mm. From the lower end of the delto-pectoral ridge to the upper end of the bone is 101 mm. The width of the lower end is 57 mm.

The radius and ulna are relatively very short. The radius measures only 96 mm. in greatest length.

The first distal carpal measures 28 mm. by 19 mm. and is 9 mm. thick. What are probably the 2nd and 3rd carpals are preserved, but as they are not in position the identification is doubtful.

The manus is fully preserved with the exception of the 3rd meta-

carpal, most of the 4th metacarpal, and the phalanges of the 4th and 5th digits.

The 1st metacarpal is in general shape much like that of *Massospondylus*, but differs in that its proximal outer corner ends in a point. In this it also differs from *Gryponyx*. The 1st phalanx differs from that of *Massospondylus harriesi* in being relatively longer and more slender.

The 2nd digit is relatively more slender than in *Massospondylus harriesi*, and the claw is unlike that of either *Massospondylus* or *Gryponyx*, about the same length as the penultimate phalanx. The claw is further remarkable from the fact that the vascular grooves meet each other on the upper side near the union of the middle and distal third, leaving the upper part of the claw separated from the lower, something like the horn of a hornbill.

The 3rd digit is a little shorter than the 2nd, and the phalanges are narrow and slender.

The 5th metacarpal is not unlike that of *Massospondylus harriesi*, but considerably smaller.

The following are the principal measurements of the bones of the manus:—

	Greatest Length.	Proximal Width.	Distal Width.
1st metacarpal	34 mm.	33 mm.	15 mm.
1st phalanx	35 ,,	28 ,,	21 ,,
Ungual phalanx ...	61 (approx.)	19 ,,	—
2nd metacarpal...............	42 mm.	26 ,,	22 ,,
1st phalanx	27 ,,	20 ,,	18 ,,
2nd phalanx	29 ,,	17 (approx.)	15 ,,
Ungual phalanx ...	32 (approx.)	11 mm.	—
3rd metacarpal missing.			
1st phalanx	19 mm.	14 ,,	13 mm.
2nd phalanx	15 ,,	12 ,,	11 ,,
3rd phalanx	16 ,,	11 ,,	11 ,,
Ungual phalanx ...	25 (approx.)	8 ,,	—
4th metacarpal and phalanges fragmentary or missing.			
5th metacarpal	26 mm.	20 mm.	15 ,,
Phalanges missing.			

The right hind foot is nearly complete, but the metatarsals have been broken across the middle, and the 4th is very badly crushed.

The following are the principal measurements of the bones :—

	Greatest Length.	Proximal Width.	Distal Width.
1st metatarsal	80 mm.	? crushed	30 mm.
1st phalanx	41 ,,	27 mm.	22 ,,
Ungual phalanx	58 (approx.)	20 ,,	—
2nd metatarsal	123 mm.	25 ,,	29 ,,
1st phalanx	44 ,,	33 ,,	28 ,,
2nd phalanx ...	34 ,,	25 ,,	24 ,,
Ungual phalanx	55 (approx.)	20 ,,	—
3rd metatarsal	130 mm.	26 ,,	35 (crushed)
1st phalanx	45 ,,	25 ,,	27 mm.
2nd phalanx ...	35 ,,	25 ,,	24 ,,
3rd phalanx......	30 ,,	21 ,,	20 ,,
Ungual phalanx	48 (approx.)	18 ,,	—
4th metatarsal	117 (crushed)	44 (much crushed)	23 ,,
1st phalanx	35 mm.	Imperfect	24 ,,
2nd phalanx ...	28 ,,	24 (approx.) mm.	23 ,,
3rd phalanx......	21 ,,	21 mm.	21 ,,
4th phalanx......	23 ,,	18 ,,	18 ,,
Ungual phalanx	37 (approx.)	15 ,,	—
5th metatarsal	65 mm.	(crushed, imperfect)	
Rudimentary phalanx missing.			

Geranosaurus atavus, g. et sp. nov.

The remains of this small Dinosaur were got by Mr. G. S. T. Mandy in the road-cutting near the summit of the Barkly Pass in Elliot. The collection of bones consists of badly crushed fragments of a skull with the anterior part of the lower jaw fairly well preserved, some slender birdlike hind-limb bones, and a number of very imperfect vertebræ. The vertebræ seem too large to have belonged to the skull, and there being thus some doubt about the bones being those of one animal I think it better to describe the jaw-bones alone and to make them the type.

As preserved, the lower jaw has the left dentary fairly complete with a considerable portion of the right and the predentary nearly perfect.

The predentary has its upper surface displayed, which is concave. It is 12 mm. long and the same in width. The outer and anterior edges are sharp and doubtless formed a horny beak.

The dentary as preserved measures 73 mm. in length, and there

is probably but little missing from the posterior end. The anterior half bears 9 teeth which have rounded roots in sockets. The teeth in the fragment of the maxilla have flat chisel-shaped crowns with the outer face feebly ridged. Probably those of the mandible were similar in this respect. The most remarkable thing about the dentition is that the most anterior of the teeth is larger than the others, and may be looked on as a canine. The total length of the dental series is 35 mm. Most of the teeth have a diameter of between 3 and 4 mm., but the anterior tooth has a diameter of 5 mm.

The specimen is from the Cave sandstone of the Stormberg Series, which, in my opinion, is of Lower Jurassic Age. Formerly the bed was believed to be Triassic, but the discovery in it of a true Crocodile (*Notochampsa*) seems to show that we should regard it as Lower Jurassic. And this discovery of a Predentate Dinosaur seems to confirm the conclusion. Even considering the sandstone as Lower Jurassic, *Geranosaurus* would still be the earliest known member of the Predentata.

All the specimens are in the palæontological series of the South African Museum, except those represented in figures 2, 3, 5, 18 and 23, which are in the Government Museum, Bloemfontein.

LITERATURE.

In Baron von Huene's recent magnificent work, "Die Dinosaurier der Europäischen Triasformation" a full list is given of the literature of the South African Stormberg Dinosaurs and of the allied forms of Europe and America.

REFERENCES TO PLATES.

Plate XIV.

Fig.
1. Left side of pelvis of *Gryponyx africanus.* × ·16.
2. Outer view of left femur of *Gryponyx africanus.* × ·15.
3. Posterior view of left femur of *Gryponyx africanus.* × ·15.
4. Outer view of left tibia of *Gryponyx africanus.* × ·15.
5. ,, ,, fibula of *Gryponyx africanus.* × ·15.
6. Right pes of *Gryponyx africanus.* × ·29.

Plate XV.

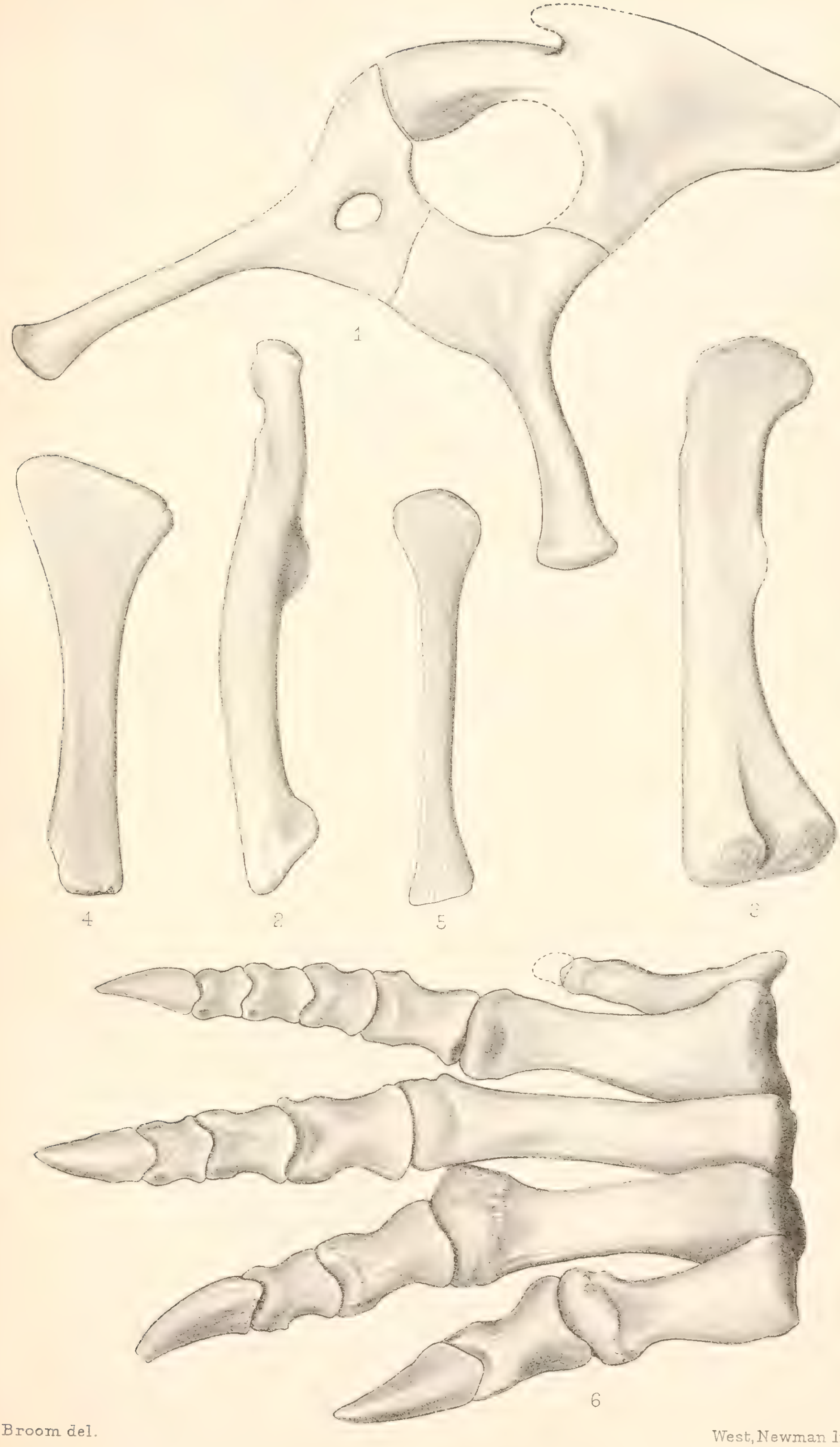
7. Left manus of *Gryponyx africanus.* × ·39. The hand is represented with the bones of the forearm and digits lying in one plane. The carpal elements are placed in what appears to be the natural position.
8. Portion of manus of *Gryponyx africanus*, with the carpals represented in the position in which they were found.
9. Left 1st metacarpal of *Gryponyx africanus.* Nat. size.
10. Left 1st metacarpal of *Massospondylus carinatus.* Nat. size.
11. Left 1st metacarpal of *Massospondylus harriesi.* Nat. size.
12. Left 1st metacarpal of *Ætonyx palustris.* Nat. size.

Plate XVI.

13. Left humerus of *Massospondylus harriesi.* × ·54.
14. Distal end of humerus of *M. harriesi.* × ·65
15. Left ulna of *M. harriesi.* × ·71.
16. Left radius of *M. harriesi.* × ·71.
17. Left manus of *M. harriesi.* × ·66. The hand is represented with what appears to be the natural position of the bones when the limb rested on the ground. The metacarpals and the penultimate phalanges of the 2nd and 3rd digits are considerably foreshortened.

Plate XVII.

18. Right pes of *Massospondylus harriesi.* × ·35.
19. Right scapula and coracoid of *Ætonyx palustris.* × ·38.
20. Right humerus of *Ætonyx palustris.* × ·41.
21. Right radius of *Ætonyx palustris.* × ·41.
22. Distal portion of right ulna of *Ætonyx palustris.* × ·41.
23. Left manus of *Ætonyx palustris.* × ·42.
24. Imperfect lower jaw of *Geranosaurus atavus.* About nat. size. The predentary is seen in front.



R. Broom del. West, Newman lith.

Fig. 1–6 Gryponyx africanus.

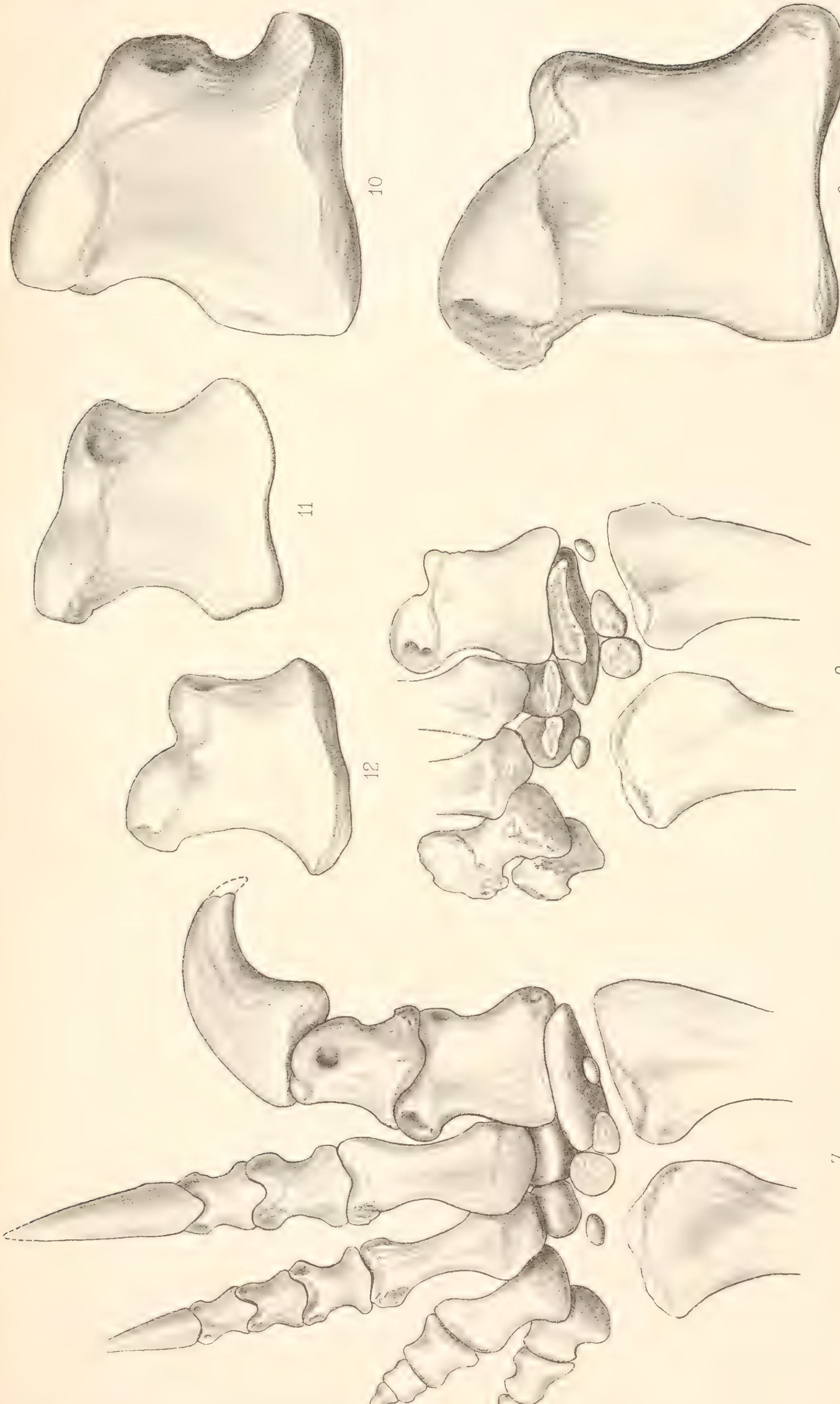


Fig. 7–9 Gryponyx africanus. Fig. 10 Massospondylus carinatus.
Fig. 11 Massospondylus harriesi. Fig. 12 Ætonyx palustris.

R. Broom del. West, Newman lith.

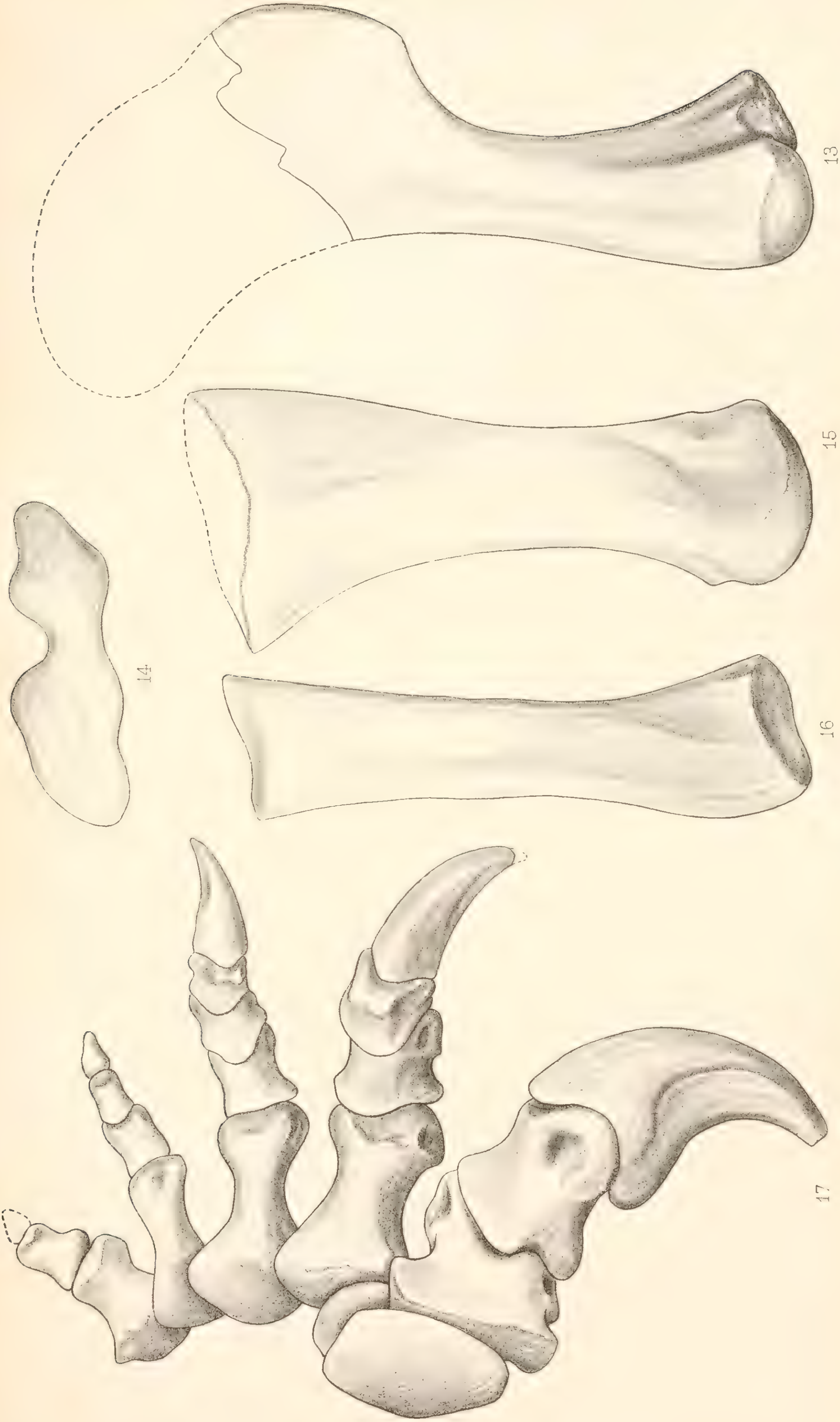


Fig. 13-17 Massospondylus harriesi.

R. Broom del.

West, Newman lith.

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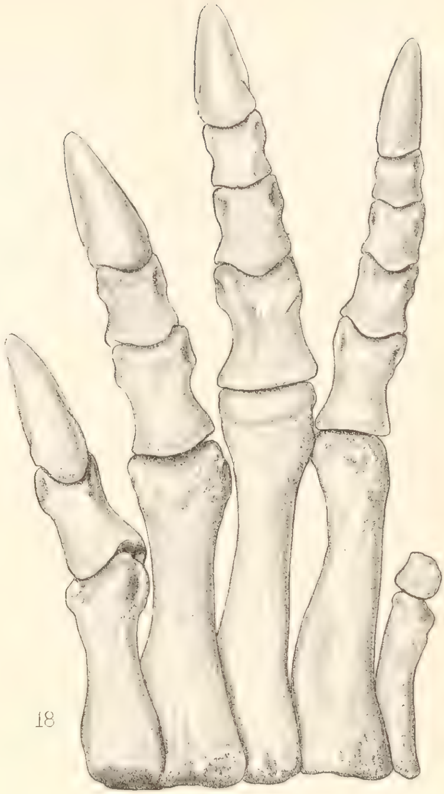

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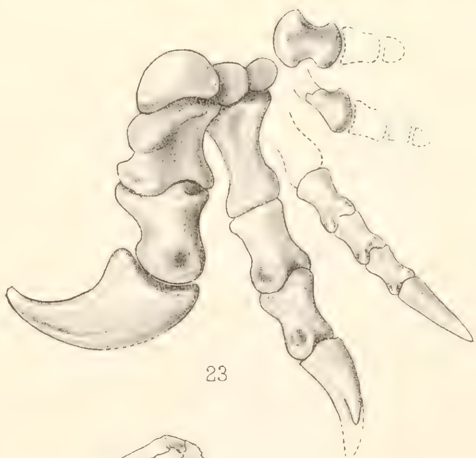

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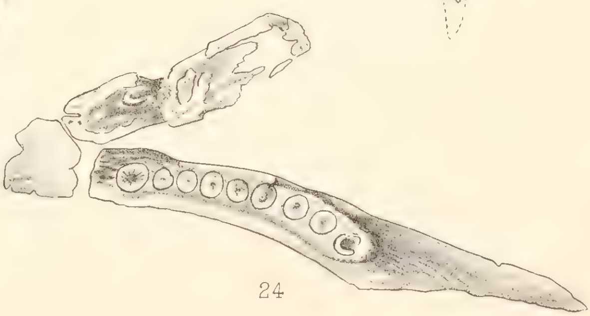

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R. Broom del.   West, Newman lith.

Fig. 18 Massospondylus harriesi. Fig. 19-23 Ætonyx palustris.
Fig. 24 Geranosaurus atavus.

14.—*Description of a New Plesiosaur* (Plesiosaurus capensis, sp. nov.) *from the Uitenhage Beds of Cape Colony.*—By C. W. Andrews, D.Sc., F.R.S., of the British Museum (Natural History).

(Plate XVIII., text-Figs. 1–4.)

In the Annual Report of the Geological Commission of the Cape of Good Hope for 1900 (1901) Messrs. Rogers and Schwarz* announced the discovery of the remains of a Plesiosaurian reptile, which were found by Mr. Schwarz in a cliff at Picnic Bush, in the valley of the Zwartzkops River, between Uitenhage and the sea. The deposit in which the fossil was found is described as a nodular clay-limestone, and belongs to the Sunday River beds of the Uitenhage Series. The age of this series seems now to have been fairly definitely settled by Dr. Kitchin † as the Upper Velangian and Lower Hauterivian horizons of the Neocomian; that is to say, corresponding in age to some part, probably the upper, of the Wealden beds of England.

So far as I am aware, this is the first mention of the occurrence of a Plesiosaurian in South Africa. The discovery is afterwards again referred to in Rogers' and du Toit's "Introduction to the Geology of Cape Colony," p. 331 (2nd ed., 1909).

The specimens were entrusted to the late Professor H. G. Seeley for description, but unfortunately he died before any account of them had appeared. Afterwards, through the kindness of Dr. A. W. Rogers, the material passed into my hands, and the present paper contains the results of my examination of the remains.

Originally the bones seem to have been embedded in hard matrix at least to a large extent, but much of this has been successfully removed, and a considerable part of the skeleton is now visible. The parts preserved are—skull, part of the mandible, some teeth,

* Appendix I., Report on the Survey of Parts of the Uitenhage and Port Elizabeth Divisions, p. 8.

† Kitchin, Ann. S. African Museum, vol. vii. (1908), "The Invertebrate Fauna and Palæontological Relations of the Uitenhage Series," p. 21.

limb bones, including portions of the femora, tibiæ, fibulæ, and a number of phalanges. These show that the animal was a typical Plesiosaur, and, in the absence of the pectoral girdle, I see no sufficient reason to regard it as other than a species of the genus Plesiosaurus. It will be shown below that it differs in several respects from other known species from approximately contemporary deposits, and it is therefore regarded as a new species, for which the name *Plesiosaurus capensis* is suggested.

The skull (Pl. XVIII., Fig. 1, text-Fig. 1) is in a fair state of preservation: nearly the whole of the palatal surface can be seen, but of the dorsal surface the greater part of the left side is concealed by the neural spines of six dorsal vertebræ which have been crushed down upon it. Part of the sub-orbital region of the right side and the right zygomatic arch are missing, and the zygoma of the left side is in part concealed by matrix. Between the temporal fossæ the parietals probably formed a well-marked sharp crest, but for the most part this has been broken away. The snout is narrow, and at the point where the maxillo-premaxillary suture crosses the alveolar border there is a slight constriction. The greatest width of the skull is between the outer ends of the quadrates, and this measurement is to the length of the skull from the occipital condyle to the tip of the snout, about as 2 to 3.

The *basi-occipital* (*b.oc.*) appears to bear the whole of the occipital condyle, which is sessile and considerably wider than high. Beneath the condyle there is a narrow vertical surface, running out laterally on to the posterior face of the postero-lateral (pterygoid) processes. The lower ends of these, and indeed the whole ventral face of the basi-occipital, are covered by the pterygoids, which meet in the middle line. It is not possible to make out the sutures between the basi-occipital and the exoccipital-opisthotics. The latter are, so far as can be seen, similar to the same elements in the other Plesiosaurs; that is to say, they consist of a columnar portion forming the sides of the foramen magnum and uniting above with the supra-occipital, and a long paroccipital process which runs outwards, downwards and backwards to the quadrate (*q.*), with which its outer end was probably in contact, though possibly it joined the outer end of the quadrate process of the pterygoid, the sutures in this region being very indistinct.

The *supra-occipital* forming the upper part of the foramen magnum is crushed over to the left, and the shape of the opening thereby distorted. At its upper end the supra-occipital united with parietals, but its precise relations with those bones cannot be made

out. As usual the posterior part of the parietals, probably together with the parietal processes of the squamosal, project some distance behind the occipital surface.

The *basi-sphenoid* is concealed by the overlapping pterygoids and by the posterior end of the parasphenoid. This latter (*pas.*) is a narrow vertical plate, not a horizontal one, as in *Murænosaurus* and *Cryptocleidus*. As in the other Plesiosaurs, it divides the posterior inter-pterygoid vacuity into two openings (*p.i.v.*) (elsewhere called the posterior palatine vacuities). Its anterior end is thrust between

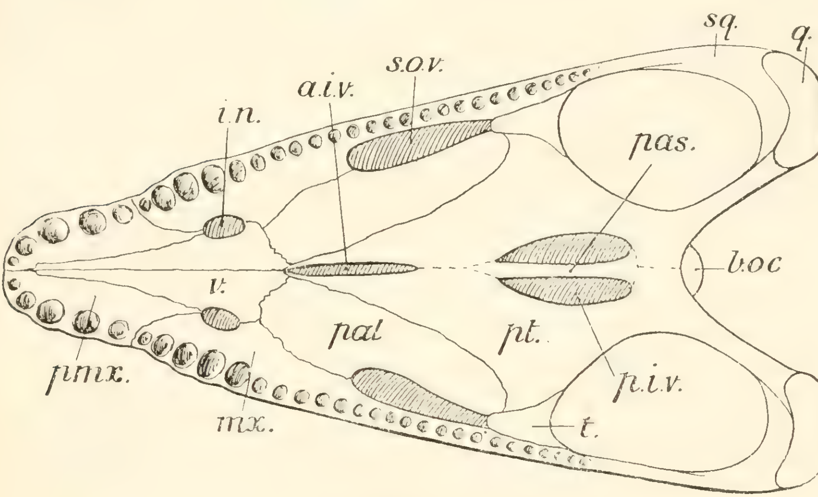


FIG. 1.

1. Diagrammatic view of the palate of *Plesiosaurus capensis*. ⅓ nat. size. *a.i.v.*, anterior interpterygoid vacuity; *b.oc.*, basi-occipital; *i.n.*, internal narial openings; *mx.*, maxilla; *pal.*, palatine; *pas.*, parasphenoid; *p.i.v.*, posterior inter-pterygoid vacuity; *pmx.*, premaxilla; *pt.*, pterygoid; *q.*, quadrate; *s.o.v.*, sub-orbital vacuity; *t.*, transpalatine bone; *v.*, vomer.

the palatine plates of the pterygoids, but its exact limits are obscure. The *pterygoids* (*pt.*) are of the usual triradiate form: posteriorly they unite with one another in the middle line beneath the basi-occipital and basi-sphenoid, and are produced backwards and outwards into thin vertically compressed processes to the quadrates. In front of their union beneath the basis cranii the median borders of these bones diverge from one another and enclose a large oval inter-pterygoid vacuity (*p.i.v.*) which, as just mentioned, is divided into two in the middle line by the parasphenoid. In front of this vacuity the anterior end of this bone is wedged in between the

about twenty cervical and fifteen dorsal vertebræ, some imperfect pterygoids for a short distance; in front of this again the pterygoids meet in the middle line for a short distance, and then are separated by a narrow anterior inter-pterygoid vacuity (*a.i.v.*). Possibly they may be in contact with one another again at their anterior ends. The outer border of the posterior ramus in front of the union beneath the basis cranii runs forwards and at first slightly outwards, then turning outwards almost at right angles to form the posterior border of the lateral ramus. The outer end of this joins the transpalatine bone (*t.*) which connects the pterygoid with the maxilla. The flat anterior ramus of the pterygoid is broad posteriorly but narrows towards its anterior end, where it joins the vomers (prevomers). On its outer side it joins the palatine in a long oblique suture.

The *palatine* (*pal*) is an elongated bone, the inner border of which, as just described, unites in suture with the pterygoid. Anteriorly the palatines converge, but do not seem to meet owing to the union of the anterior ends of the pterygoids with the vomers; at the same time it should be noted that in this specimen the sutures are not very distinct. The rounded anterior ends of the palatines unite with the vomers, externally to these they join the palatine plates of the maxilla, for a short distance behind which they are separated from that bone by a narrow sub-orbital vacuity (*s.o.v.*), which is closed posteriorly by the transpalatine bone (*t.*), with which the hinder end of the palatine unites. The transpalatine bone (*t.*) is a triradiate element, its outer side unites with the maxilla, its inner branch underlies the outer end of the lateral ramus of the pterygoid, and its anterior concave border is in contact with the palatine, its anterior angle closing the sub-orbital vacuity (*s.o.v.*) posteriorly.

The *vomers* (*v.*) (prevomers of Broom) are closely united with one another in the middle line, the original suture between them being only visible in their expanded posterior portion. The united bones extend far forwards between the premaxillæ, almost to the pits occupied by the tips of the replacing teeth. Followed back to the nares (*i.n.*), they widen gradually and are convex from side to side; at the nares they are again narrowed and the palatal surface becomes flat. Behind the nares they widen out into a fan-like expansion, and, as already mentioned, the suture between them is visible, and is situated at the bottom of a median depression. In front of the nares the vomers lie between the palatine plates of the premaxillæ, which extend back just to the anterior angle of the narial opening (*i.n.*). Behind the nares they unite with the palatine plates of the maxilla externally, internal to this with the palatines, and in the

middle line probably with the anterior ends of the pterygoids, though this is not quite clear.

The *premaxillæ* (*pmx.*) which form the narrow muzzle, each bear alveoli for five teeth. Of these the anterior one is small and close to the middle line; the second is rather larger; both these teeth seem to have been directed forward. The third and fourth teeth are large, the fifth again smaller. Immediately behind the last there is a short diastema crossed by the maxillo-premaxillary suture. Within the row of alveoli and separated from them by a flattened area there is a row of pits which mark the points at which the replacing teeth appear. Internal to the two posterior

Owing to a regrettable printer's error a line has been misplaced in Dr. C. W. Andrews' paper, Annals S. Afr. Museum, Vol. VII. Part 4.

The top line of p. 312 should be the top line of p. 310, and the sentence to which it belongs should read:—

The parts preserved are—skull, part of the mandible, some teeth, about twenty cervical and fifteen dorsal vertebræ, some imperfect limb bones, including portions of the femora, tibiæ, fibulæ, &c.

be seen, however, that the first tooth was small, while the succeeding three were greatly enlarged, the third being the largest. The palatine portion of the bone is in contact with the premaxilla in front; behind this it forms the outer border of the internal nares; behind this again it joins the palatine for some distance, but posteriorly is separated from it by the narrow sub-orbital vacuity (*s.o.v.*). Behind this it unites with the transverse bone and posteriorly probably with the jugal. The facial surface is imperfectly preserved: the maxillo-premaxillary suture runs from the alveolar border upwards and backwards, then backwards nearly parallel with the middle line as far as the external nares which form deep notches in the border of the bones, their inner edge being formed by the facial processes of the premaxillæ. The relations of the facial region of

about twenty cervical and fifteen dorsal vertebræ, some imperfect pterygoids for a short distance; in front of this again the pterygoids meet in the middle line for a short distance, and then are separated by a narrow anterior inter-pterygoid vacuity (*a.i.v.*). Possibly they may be in contact with one another again at their anterior ends. The outer border of the posterior ramus in front of the union beneath the basis cranii runs forwards and at first slightly outwards, then turning outwards almost at right angles to form the posterior border of the lateral ramus. The outer end of this joins the transpalatine bone (*t.*) which connects the pterygoid with the maxilla. The flat anterior ramus of the pterygoid is broad posteriorly but narrow-

another in the middle line, the original suture between them being only visible in their expanded posterior portion. The united bones extend far forwards between the premaxillæ, almost to the pits occupied by the tips of the replacing teeth. Followed back to the nares (*i.n.*), they widen gradually and are convex from side to side; at the nares they are again narrowed and the palatal surface becomes flat. Behind the nares they widen out into a fan-like expansion, and, as already mentioned, the suture between them is visible, and is situated at the bottom of a median depression. In front of the nares the vomers lie between the palatine plates of the premaxillæ, which extend back just to the anterior angle of the narial opening (*i.n.*). Behind the nares they unite with the palatine plates of the maxilla externally, internal to this with the palatines, and in the

middle line probably with the anterior ends of the pterygoids, though this is not quite clear.

The *premaxillæ* (*pmx.*) which form the narrow muzzle, each bear alveoli for five teeth. Of these the anterior one is small and close to the middle line; the second is rather larger; both these teeth seem to have been directed forward. The third and fourth teeth are large, the fifth again smaller. Immediately behind the last there is a short diastema crossed by the maxillo-premaxillary suture. Within the row of alveoli and separated from them by a flattened area there is a row of pits which mark the points at which the replacing teeth appear. Internal to the two posterior pits the surface of the premaxilla is raised into a ridge on a level with the vomer against which it abuts. The facial surface of the premaxillæ consists of a broad anterior region, convex from side to side with a median groove marking the line of union of the two bones, and a backwardly prolonged narrow facial process, the two bones uniting in this region to form a prominent ridge with concave sides which extends back between the orbits; how far back the facial processes of the premaxillæ extend cannot be determined from this specimen, but probably, judging from what occurs in some of the Oxford Clay genera, they joined the frontals a little in front of the level of the posterior border of the orbits. It is possible that these backward prolongations of the premaxillæ may, as suggested by Williston, include some other element, possibly the nasal, though I have never seen any evidence of this. The upper surface of the anterior part of the premaxillæ is much roughened and bears a number of vascular foramina.

The *maxilla* (*mx.*) is not completely preserved on either side of the skull, and it is not possible to say how many teeth it bore; it can be seen, however, that the first tooth was small, while the succeeding three were greatly enlarged, the third being the largest. The palatine portion of the bone is in contact with the premaxilla in front; behind this it forms the outer border of the internal nares; behind this again it joins the palatine for some distance, but posteriorly is separated from it by the narrow sub-orbital vacuity (*s.o.v.*). Behind this it unites with the transverse bone and posteriorly probably with the jugal. The facial surface is imperfectly preserved: the maxillo-premaxillary suture runs from the alveolar border upwards and backwards, then backwards nearly parallel with the middle line as far as the external nares which form deep notches in the border of the bones, their inner edge being formed by the facial processes of the premaxillæ. The relations of the facial region of

the maxillæ to the bones behind cannot be made out, and it is uncertain whether there is a lachrymal, a pre-frontal, or a nasal. Probably the bone forming the anterior part of the raised rim of the roof of the orbit was the pre-frontal, while that forming the posterior part was the post-frontal, but no sutures are visible. Neither can sutures be seen between the frontals and the surrounding bones. The pineal foramen seems to have been just opposite the anterior border of the temporal fossæ and probably marks the anterior limit of the parietal bones. These formed a high, narrow, sagittal crest between the temporal fossæ, but in this specimen its summit is broken away. Posteriorly these bones widen out and project backwards behind the level of the foramen magnum; how far the lateral expansions of the parietals are overlapped by the upper limbs of the squamosals cannot be determined. The ventral process of the squamosal (*sq.*) can be seen to be closely adherent to the posterior and outer face of the large quadrate (*q.*) extending far down its side. The zygomatic process seems to have been wide, but the relations of its anterior end to other bones cannot be seen. The *quadrate* (*q.*) is relatively very large: its anterior face is concave from side to side, while its posterior face is convex in the same direction. The articular surface for the mandible is imperfect, but must have been very wide, as is shown also by the width of the articular surface of the mandible. The outer face of the quadrate, as already mentioned, was overlapped by the ventral process of the squamosal, while the inner side unites with the quadrate ramus of the pterygoid and probably also with the outer end of the paroccipital process of the opisthotic, though possibly this only supports the quadrate through the medium of the pterygoid.

The *mandible* (Pl. XVIII., Figs. 2, 3) is only imperfectly preserved, the symphysial region being completely wanting. It seems to have been very strongly built for the size of the skull. The articulation for the quadrate is very broad; it consists of two concave surfaces, the inner being the larger, separated by a slight convexity: both in front and behind it is bordered by a strongly raised rim, so that the articulation must have been a very strong one. On the outer side of the jaw, just beneath the articular surface, there is a deep and roughened pit or groove, apparently for the attachment of ligament. The post-articular process is short and broad; its inner border is rounded, while the outer forms a sharp edge. Its upper portion is formed by the hinder part of the united surangular and articular bones (Pl. XVIII., Figs. 2 and 3, *s. ang.* and *art.*), the lower portion is constituted by the angular (Fig. 3, ang.). In

front of the articular surface the upper border, formed by the united surangular and articular, rises to a blunt coronoid angle where it meets the dentary on its outer side and the coronoid (*cor.*) on the inner; the anterior limits of the coronoid are not known, but it seems to have extended as a thin plate, closely adherent to the inner face of the dentary, forwards to about the level of the middle of the dental series. The greater part of the dentigerous part of the mandible is formed, as usual, by the dentary, which is the only element visible on the outer side of this part of the jaw. On its inner face the upper part of the posterior end is covered by the closely adherent coronoid, while beneath this is the thin plate-like splenial (*spl.*) which closes Meckel's groove, and probably extended forward to the symphysis into the formation of which it perhaps entered: posteriorly it is prolonged back some distance behind the level of the coronoid angle, forming the lower (inner) edge of the opening of the dental (Meckel's) canal. Beneath the splenial and on the inner side of the dentary the angular sends forward a long tapering process, the anterior end of which is concealed by the overlap of the splenial upon the dentary. In the neighbourhood of the symphysis the dentary widens out and bears at least three greatly enlarged teeth: behind these the teeth are smaller and continue about equal in size for the first six or seven: behind these again there is a gradual reduction in size to the end of the series. The outer face of the dentary is marked by numerous vascular grooves and foramina.

Several teeth (Pl. XVIII., Fig. 4) are preserved, differing much in size and to some extent in shape. The larger ones have long conical, slightly curved crowns, circular in section and probably terminating in a sharp point. On the inner (concave) side of the crown the enamel is raised into numerous fine longitudinal ridges which tend to unite with one another in pairs as they are followed towards the tip of the crown; similar ridges occur to a less extent on the anterior and posterior faces of the crown, but on the outer (convex) face the enamel is almost smooth, only a very faint ridging being visible. The roots of the teeth are very large, smooth and circular in section. In the smaller teeth (Pl. XVIII., Fig. 4) the crown is more strongly curved. The enamel ridges are relatively larger and fewer in number, but their arrangement is the same as in the large teeth.

Of the vertebral column (Pl. XVIII., Figs. 5, 6; text-Figs. 2, 3) a considerable portion is preserved. Twenty-one or twenty-two cervicals are present, of which eleven are anterior, the remainder posterior and forming a continuous series with the fifteen pectorals

and dorsals that are preserved. In the anterior cervicals (Pl. XVIII., Figs. 5, 6) the centra are considerably wider than long; their articular faces are wider than high and are deeply concave, the centre being occupied by a large sharply defined fossa (Fig. 6). This depression seems to be more deeply excavated on the posterior than on the anterior face, and is particularly sharply defined in the more anterior vertebræ. In these also the centra bear a sharp hypa-

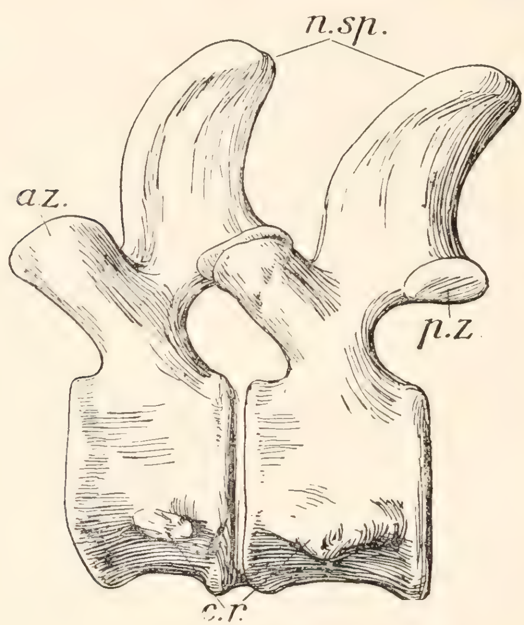


Fig. 2.

2. Posterior cervical vertebræ of *Plesiosaurus capensis;* from left side. About ⅔ nat. size.

a.z., anterior zygapophysis; *c.r.*, bases of cervical ribs; *n. sp.*, neural spine; *p.z.*, posterior zygapophysis.

pophysial ridge (Fig. 5*a*), which is as it were pinched up and has on either side of it a concave surface; near its anterior end there are in some cases small sharp lateral projections which probably served for the insertion of tendons. On either side of the ridge and close to it are the nutritive foramina. The cervical ribs are fused with the ventro-lateral borders of the centra, and above them the sides of the centra are concave both from side to side and from above downwards. The neural arch is high and is fused with the centrum; the

zygapophyses are relatively large; the neural spines are incomplete in all the anterior cervicals. In the posterior cervicals (text-Fig. 2) the hypapophysial ridge is broadly rounded, and is best marked in the anterior part of the centrum; the ventral nutritive foramina are here separated by an interval of about 1·5 cm. It is possible that some of the posterior cervical ribs were still free. In this region the zygapophyses are large and the anterior ones project strongly forwards. The neural spines, which are not very high, slope backwards; their anterior border is convex, the posterior concave. In the hindermost cervicals the rib-facet passes up on to the arch, but the condition of the specimen makes it difficult to determine in which the passage actually takes place; probably the tenth and eleventh of the series as preserved may be regarded as the transitional (pectoral) vertebræ.

The dorsals (text-Figs. 3A, 3B) have the centra relatively shorter than the cervicals and at the same time rounder, the transverse diameter being little greater than the vertical. The ventral surface of the centrum is almost evenly rounded from side to side, there being only a slight trace of a hypapophysial ridge, on either side of which are the nutritive foramina (*n.f'.*). The upper part of the sides of the vertebræ is concave in all directions; the lower border of the concavity approximately marks the line of the suture between the centrum and the arch; at its lower angle there is a vascular foramen (*n.f.*). The articular ends of the centrum are nearly circular except for the presence of a slight depression beneath the neural canal; they are fairly deeply concave but without the sharp central depression seen in the cervicals; their outer edges are sharp and well defined. The neural arches are lower than in the cervical region and the zygapophyses are proportionately smaller; the anterior zygapophyses (*a.z.*) project considerably forwards, the whole of their articular surface lying in front of the centrum. A strong ridge runs from the anterior zygapophysis to the anterior border of the transverse process, which in the anterior dorsals is situated low down on the arch but passes upwards as the series is followed back; it is compressed from above downwards. The height of the neural spines (*n.sp.*) in the dorsal region is not known, all having been broken off short.

Of the limbs (text-Fig. 4) there remain portions of two paddles, which I regard as posterior. One consists of the much-shattered and imperfect distal portion of the femur with the tibia and fibula attached. The other is the upper part of the shaft of the other femur and the detached tibia and fibula, in excellent preservation,

there is also a carpal, probably a fibulare, and a number of phalanges, which cannot be placed. The femur seems to have possessed a well-developed trochanter, and on the ventral face of the shaft there was a rugose surface for the attachment of muscles; distally it expanded considerably (text-Fig. 4, *fem.*); indeed, its expansion seems to have

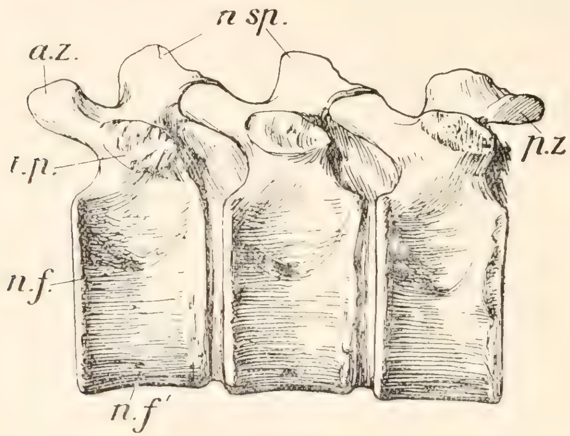


Fig. 3a.

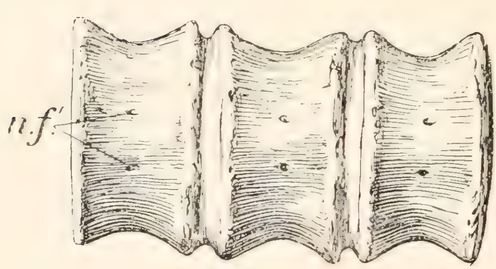


Fig. 3b.

3. Dorsal vertebræ of *Plesiosaurus capensis;* A. from left side, B. from below. $\frac{2}{3}$ nat. size.

a.z., anterior zygapophyses; *n.f.* and *n.f.'*; nutritive foramina; *n. sp.*, neural spine; *p.z.*, posterior zygapophysis; *t.p.*, transverse processes.

been too great for articulation with the tibia and fibula only, and probably it also supported a posterior accessory ossicle. The tibia and fibula (text-Fig. 4, *tib. fib.*) are more elongated than one would expect to find them in a Wealden form, and in this respect the paddle much resembles that of some of the Lower Lias Plesiosaurs, *e.g.*, *P. hawkinsi.* The tibia (*tib.*) articulates with the femur by a long

and slightly convex facet; its anterior border is sharp and almost straight, while the post-axial border is concave in its proximal half but distally is occupied by a large facet for union with the fibula, with which there seems to have been no contact at the proximal end. Distally there is a long, flat facet for the tibiale; in front of this there is a small, oblique facet and behind it a longer, also oblique facet for the intermedium. The fibula (*fib.*) is a kidney-shaped bone; proximally it bears a large, nearly straight surface for union with the femur; anteriorly it has in its proximal portion a concave,

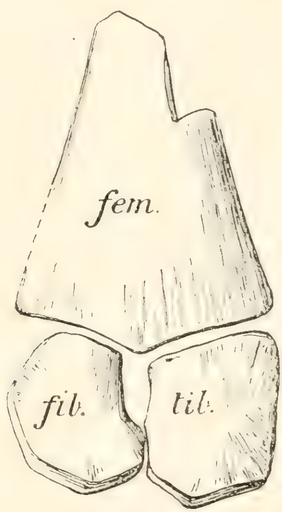


FIG. 4.

4. Portion of hind paddle of *Plesiosaurus capensis*. About ⅓ nat. size. *fem.*, femur; *fib.*, fibula; *tib.*, tibia.

sharp-edged border and distally a facet for union with the tibia. The remainder of the border is occupied by four facets—one for the intermedium, behind this a surface for the fibulare, next a post-axial surface looking nearly directly backwards, and lastly a small surface looking upwards and backwards, which probably supported an accessory ossicle which also articulated with the femur. The chief peculiarity of this tibia and fibula, apart from their length, is that, although they unite distally, proximally there is a considerable interval between them which is only closed above by the humerus. I am not acquainted with any Plesiosaur in which exactly the same thing is seen; usually in the post-Liassic Plesiosaurs the tibiæ and

fibulæ are much shortened, and if there is any interval between them, it is a small foramen or slit which is enclosed above and below by the meeting of these bones.

For comparison of this species with previously described species from the same or approximately the same horizon the cervical vertebræ are of the greatest importance, since the skull is quite unknown in the other species and only a few odd limb bones have hitherto been found. The cervical vertebræ are very similar to those of some of the nearly contemporaneous forms, particularly in the presence of a sharply defined and deep central depression in the middle of the more gently concave articular surfaces of the centra, but in all cases differences are apparent which forbid the inclusion of this form in any of the species hitherto described.

The forms which seem to resemble the present species most nearly are *Plesiosaurus degenhardti* Koken, *P. limnophilus* Koken, and *P. valdensis* Lydekker, sp.; there is also a certain amount of similarity to *P. bernardi* Owen and some other species.

In *Plesiosaurus degenhardti* * of Koken the form of the centra of the cervicals differs considerably, the height of their centra being greater than either their width or length; in the present species the width is the greater, and at the same time in *P. degenhardti* the edges of the articular surfaces are more rounded and thickened and the zygapophyses are smaller. The difference in the proportions of the centra is shown if we compare centra of approximately the same size of the two species: thus, in the present species, if the length of the centrum be taken as 100, the width will be about 156, the height 138; while in *P. degenhardti*, the length being 100, the width will be 127, the height 152.

From *Plesiosaurus limnophilus* † of Koken the difference is also well marked, the length of the centrum being about equal to the width, while in *P. capensis* it is much less. In a vertebra from the Wealden of Cuckfield, Sussex, ascribed by Lydekker ‡ to *P. limnophilus*, but regarded by Koken as probably distinct, the length and height of the centrum are about equal, but the width is greater. Comparison with *Plesiosaurus valdensis* § shows a much more marked similarity; in this case, the length of the centrum being taken as 100, the width is 151, the height 129—proportions which

* Koken, Palæont. Abhandl., vol. iii. (1887), p. 414; see also vol. vii. (1896), p. 122, pl. iii.

† Koken, *op. cit.*, vol. iii. (1887), p. 417.

‡ Lydekker, Catal. Foss. Rept. Brit. Mus., pt. ii. (1889), p. 224.

§ Lydekker, *tom. cit.*, p. 188.

approach very nearly to those of some of the vertebræ here described. In both cases also there is a sharp hæmapophysial ridge with a concavity on each side, and the articular surface is strongly concave with a sudden depression in the middle; this last character is more strongly marked in the present species. The neural spines in *Plesiosaurus valdensis* also resemble those of the present species, being rather low and curved backwards (see Lydekker, Catal. Foss. Rept. Brit. Mus., pt. ii., p. 188, fig. 61). There are, however, a number of differences in detail which seem to render it impossible that our specimen is specifically identical with this species.

Comparison of the proportions of the cervical vertebræ of different species of Plesiosaurs is only of value in a very general way since the vertebræ have been, for the most part, found isolated or in small groups, so that their position in the neck is usually uncertain, and they may have belonged to animals of different sizes. Nevertheless, on the whole it may be taken as fairly certain that *Plesiosaurus capensis* is a member of the group of small Plesiosaurs which in Europe is represented by *P. degenhardti* and *P. valdensis* from the Wealden, and perhaps by *P. bernhardi* from the Cambridge Greensand.

The occurrence of a Plesiosaur in South Africa is of peculiar interest since it is not improbable that the group may have been derived from some form related to the Therocephalia remains of which are found on the Permian of that region.

The approximate dimensions (in centimetres) of the type specimen of *Plesiosaurus capensis* are:—

SKULL.

Length from tip of snout to occipital condyle	27·7
Length from tip of snout to hinder point of quadrate	32·6
Length from tip of snout to vertex	29·3
Length from tip of snout to external narial opening	10·4
Width between outer angles of quadrates	18·3
Width of snout where the maxillo-premaxillary suture crosses the alveolar border	5·8

VERTEBRÆ.

	Cervicals.			Dorsals.	
Length of centrum in mid-ventral line	1·9	2·1	2·5*	3·2	2·8
Width of posterior articular face	3·0	3·3 (app.)	3·6	5·0 (app.)	4·6
Height of articular face	2·5	2·7 (app.)	3·1	4·1	4·1
United length of the two figured (text-Fig. 2) posterior cervical vertebræ					7·0
Height to top of neural spine of posterior cervical vertebræ					11·1

* Vertebra figured Pl. XVIII., fig. 6.

Distance from anterior angle of pre-zygapophysis to the posterior angle ot the post-zygapophysis of one of above	5·6
United length of the centra of the three figured (text-Figs. 3A, 3B) dorsal vertebræ	9·1
Length of middle centrum of the three	2·7
Length of anterior angle of pre-zygapophysis to posterior angle of post-zygapophysis	4·4
Width of the middle of the centrum	3·7

FEMUR.

Approximate width of distal end	10·5

TIBIA.

Length	6·0
Width	5·2

FIBULA.

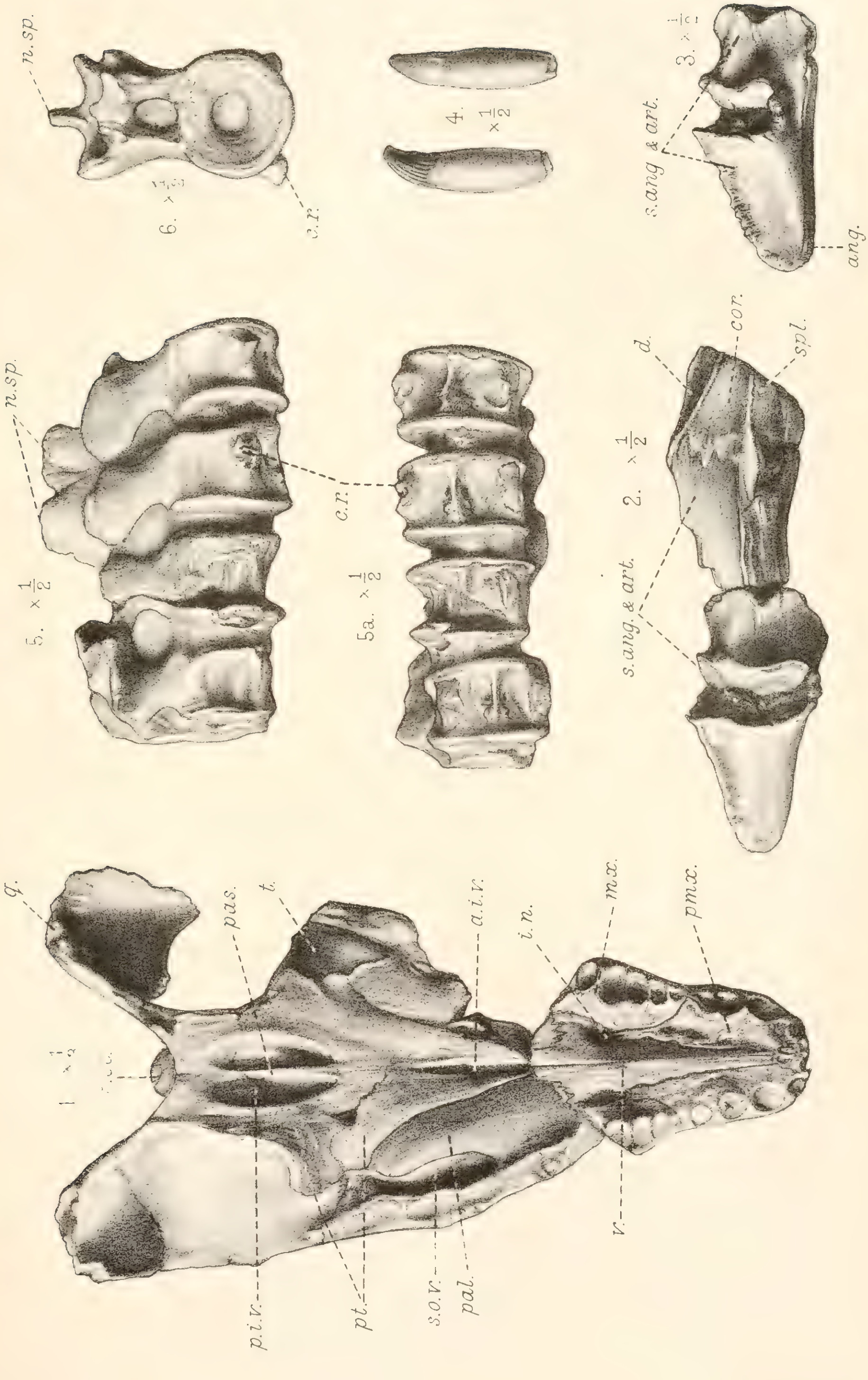
Length	6·0
Width (approx.)	4·5

EXPLANATION OF PLATE XVIII.

FIG.

1. *Plesiosaurus capensis*, n.sp.; palatal view of skull. ⅓ nat. size.
2. Ditto; hinder portion of left ramus of mandible. ½ nat. size.
3. Ditto; hinder portion of right ramus of mandible. ½ nat. size.
4. Ditto; sides and outer view of a tooth. ½ nat. size.
5. 5A. Ditto; anterior cervical vertebræ from side (5) and from below (5A).
6. Ditto; anterior cervical vertebra, from behind. ½ nat. size.

a.i.v., anterior interpterygoid vacuity.
ang., angular.
b.oc., basi-occipital.
cor., coronoid.
c.r., cervical rib.
d., dentary.
i.n., internal nares.
mx., maxilla.
n.sp., neural spine.
pal., palatine.
pas., parasphenoid.
p.i.v., posterior interpterygoid vacuity.
pmx., premaxilla.
pt., pterygoid.
q., quadrate.
s. ang. art., surangular and articular.
s.o.v., suborbital vacuity.
spl., splenial.
v., vomer.



G.M.Woodward del.et lith. West, Newman imp.

15.—*On a New Species of* Propappus, *and on the Pose of the Pareiasaurian Limbs.*—By R. Broom, M.A., D.Sc.

(Plates XIX.—XXI.)

About a year ago Dr. A. W. Rogers, of the Cape Geological Commission, discovered on the farm Hoedemakers Kraal, Beaufort West district, much of the skeleton of a small species of *Propappus*.* The skull and most of the anterior part of the vertebral column are missing, and some of the limb bones are badly weathered, but a few of the presacral vertebræ are beautifully preserved, while most of the bones of the right fore and hind limbs are present in perfect condition. There are also preserved large numbers of dermal ossicles, and there can be little doubt that as in *Propappus omocratus* the whole of the back and probably much of the sides of the animal were protected. There seems some reason to believe that even the limbs were protected by small dermal bones. The present specimen, though manifestly belonging to the genus *Propappus*, differs from *P. omocratus*, not only in being considerably smaller, but in a number of important characters, and for it I propose the name *Propappus rogersi.*

Vertebræ.

The best-preserved vertebræ are a lower dorsal, possibly the 19th, and two somewhat more anterior, possibly 13th and 15th.

The vertebra, which is evidently from the mid-dorsal region, and may be the 13th, is the most perfectly preserved Pareiasaurian vertebra that I have had an opportunity of examining. It agrees pretty closely with the dorsal vertebræ of *Pareiasaurus serridens*, and also with those of *Propappus omocratus*, but differs in its proportions. The greatest height of the vertebra is 135 mm.; the maximum width across the transverse processes 147 mm.; and the length of the centrum 50 mm. The spine is short, rising only 28 mm. above the curve formed by the posterior zygapophyses.

* See Annual Report of the Geological Commission for 1910, p. 18.

These posterior processes are well differentiated from the transverse processes, and pass outwards and slightly backwards. From the posterior edge of each articular surface there passes inwards and slightly downwards a bony ridge, which, with the upper edge of the zygapophyses demarcates a bony lozenge-shaped slightly concave surface on the back of the vertebra. The lower angle of the bony ridge forms the roof of part of the spinal canal, but there is no hyposphene. The transverse process is well developed and has a moderately large articulation for the single-headed rib. On the front of the process is the anterior zygapophysis, from which there runs inwards and slightly downwards a bony ridge as on the posterior side of the vertebra, but here the ridges do not meet. The vertebra of *Propappus rogersi* differs from that of *P. omocratus* in that the greater part of the centrum lies below a line joining the two costal articulations.

The lower dorsal vertebra, which I think may be the 19th, measures in height 162 mm., and in width across the transverse processes 156 mm. The spine is 35 mm. in height. The posterior aspect of this vertebra much resembles that of the other, but the large lozenge-shaped surface is flatter and is divided by a median low ridge. The transverse process is very massive, and the articular surface for the rib much broader and shorter than in the more anterior dorsals. The articular surface of the body is nearly normal, measuring 63 mm. in both diameters. The length of the body is about 50 mm.

Shoulder Girdle.

The upper half of the scapula is missing, but the lower part of the girdle is well preserved. It resembles closely the shoulder girdle of *Pareiasaurus serridens*, differing only a little in the proportion of certain parts and in the shape of the acromion. The sutures are almost completely obliterated, but there seems little doubt that the usual elements—scapula, coracoid, and precoracoid—are present.

The scapula has a broad lower end, which articulates with or rather is anchylosed to the coracoid and precoracoid. It probably forms about half of the glenoid cavity, and the articular surface is divided into a large posterior part and a small anterior, which looks more directly outwards and downwards. Below the anterior edge of the glenoid cavity lies the large precoracoid foramen, which passes almost directly upwards, forming a deep groove on the inner side of the scapula. The preglenoid portion of the base of the scapula is about the same size as the glenoid, in this differing from the

condition in *Pareiasaurus*, where the former is much smaller. The acromion process is large and differs from that of *Pareiasaurus* in being directed more upwards than forwards. Above the acromion the scapula is comparatively narrow, but stout.

The coracoid is perfectly preserved. The subglenoid portion is roughly about the size of the glenoid cavity. The lower and posterior corner is truncated, and doubtless articulated with a cartilaginous sternum. The whole lower border of the coracoid and precoracoid has a flattened and thickened edge, probably for a short articular cartilage which met the similar cartilage of the other side. The inner side of the lower part of the precoracoid and of part of the coracoid is very markedly concave.

The following are some of the principal measurements:—

Posterior end of coracoid to top of acromion	275 mm.
Greatest width of glenoid	130 ,,
Width of scapula immediately above acromion ...	60 ,,
Thickness of scapula immediately above acromion	40 ,,

Humerus.

The right humerus is in perfect condition, and while resembling that of *Pareiasaurus serridens* it differs rather strikingly in one or two points. As I pointed out some years ago, the British Museum specimen of *Pareiasaurus baini* gives a most misleading idea of the animal from the fact that in restoring the humerus the upper half was fixed on to the lower at a wrong angle. The articular head of the bone is placed nearly in the same plane as the lower portion of the bone. In *Pareiasaurus serridens* the head makes with the distal portion an angle of about 70°. In *Propappus rogersi* the head makes with the distal end of the bone an angle of only about 30°. But to make up for the very small rotation of the shaft, the delto-pectoral crest is twisted very abruptly forwards and developed into a prominent knob, which stands out at right angles to the plane of the distal part of the humerus. The head of the bone is very similar to that of *Pareiasaurus,* being similarly arranged to fit the peculiarly shaped glenoid cavity. Most probably it had a thick pad of cartilage. The greatest width of the head of the bone is 178 mm. The middle of the shaft is very narrow, measuring only 48 mm. in diameter. The lower half of the bone agrees closely with that of *Pareiasaurus.* There is a well-developed entepicondylar foramen, but no ectepicondylar. The articular surface for the radius and ulna is large with a rounded part for the head of the radius and

a saddle-shaped part for the ulna. The ulnar part passes round on to the back of the bone to a much greater degree than in *Pareiasaurus*, from which we may infer that *Propappus* could straighten its limb more than *Pareiasaurus*. The width of the lower end of the humerus is 175 mm.

The total length of the humerus is 267 mm., as compared with 318 mm. in *Propappus omocratus*.

Radius and Ulna.

The radius is preserved in perfect condition, and the ulna only lacks the distal end.

The radius is a columnar bone with a moderately straight shaft and dilated ends. The proximal end presents an oval surface 86 mm. × 60 mm. It is moderately deeply concave. The narrowest part of the shaft measures 37 mm. × 26 mm. The distal end is more massive than the proximal. The articular surface measures 78 mm. by about 60 mm., and is somewhat kidney-shaped.

The ulna has a remarkably well-developed olecranon process, which passes back for about 38 mm. behind the articular surface. The articular surface is concavo-convex, measuring 70 mm. in length and about the same in width. The large olecranon process when viewed from behind is club-shaped, with a large number of shallow longitudinal markings on the surface.

Pelvis.

The pelvis is well preserved, the innominate of the right side being nearly perfect, and much of the left side also present, though badly weathered. Though in general type the pelvis is distinctly Pareiasaurian, the differences from the pelvis of *Pareiasaurus* itself are much more marked than in the case of the shoulder girdle.

The ilium has its axis passing upwards and forwards from the acetabulum. The crest is of considerable length and fairly straight. Anteriorly it turns abruptly outwards for a distance about equal to half of the antero-posterior portion. Owing to this outward turning of the crest the anterior part of the ilium is triangular in section, and there is a large flat surface looking forwards. Internally the ilium is irregularly concave for the reception of the large first sacral rib. The greatest length of the iliac crest is probably about 190 mm. The transverse portion measures 100 mm. From the top of the

acetabulum to the most anterior part of the iliac crest is 190 mm. The narrowest part of the ilium is 65 mm.

The acetabulum is large, and but for a marked development of the upper iliac border and of the ischial border would be rather shallow. Its greatest width is 115 mm., and its vertical measurement 95 mm. The three bones forming it are so completely anchylosed that their limits cannot be with certainty determined.

The pubis and ischium are so completely anchylosed that no trace of the dividing suture can be detected, and the bones of the two sides are likewise completely anchylosed along the symphysis. The bones are massive, and represent a somewhat specialised modification of the plate-like type.

The pubis is considerably longer vertically than antero-posteriorly. From the anterior part of the symphysis to the point where it probably unites with the ilium is about 170 mm. The greatest antero-posterior measurement is probably not more than 100 mm. There is a large pubic foramen situated as shown in the figure. As the bone lies in the body the pubic canal passes almost directly upwards. The outer half of the front edge of the pubis is much thickened and bent downwards and forwards, and I think there is little doubt that it supported a prepubic cartilage. This surface for the cartilage measures about 90 mm. in length, and varies from 20 to 30 mm. in width. The lower end of the surface rises abruptly from the inner part of the anterior border of the pubis.

The ischium measures about 180 mm. by about 135 mm., and but for the great vertical depth would be practically of the plate-like type. The symphysis is very thick. In the pubic region it reaches a thickness of 68 mm., but becoming thinner in the ischial region it averages about 55 mm., and at the posterior part of the ischium it is only about 35 mm.

Femur.

The right is preserved in perfect condition. It resembles pretty closely the femur of *Propappus omocratus*, but differs from that of *Pareiasaurus serridens* in a number of important features. It agrees with the femur of *Propappus omocratus* in having the axis of the upper third of the bone making an angle with the lower part of the shaft of about 45°. It also agrees with it, and differs from that of *Pareiasaurus* in having the middle of the shaft constricted and nearly round. And lastly, it agrees with the femur of *Propappus omocratus* in that the trochanter minor is directed backwards and outwards, so that a deep concavity is formed between it and the

trochanter major. The femur of *Propappus rogersi* differs from that of *P. omocratus* in being shorter and stouter; in having the head more largely cartilaginous; in having the great trochanter more directly continuous with the articular surface; and in having the outer condyle relatively larger.

The following is a comparison of the measurements of the femur in the two species:—

	Propappus omocratus.	*Propappus rogersi.*
Length of femur	335	290
Width of head	75	75
Length of head	117	112
Width of shaft at narrowest part	60	60
Width of distal end of the bone	137	147

Tibia and Fibula.

The right tibia and fibula are both in beautiful preservation. The tibia resembles considerably that of *Propappus omocratus*, but differs in a few points. The proximal articular end had probably a considerable pad of cartilage. As preserved it is a large flattened surface rising up to a prominent boss in the middle. It measures 112 mm. by 77 mm. as against 110 mm. by 85 mm. in *Propappus omocratus*. The distal articular surface is kidney-shaped and measures 94 mm. by 55 mm., as against 90 mm. by 60 mm. in *Propappus omocratus*. The total length of the bone is 177 mm.: in *P. omocratus* it measures 200 mm.

The fibula is the most perfect Pareiasaurian fibula known. It is a slightly curved bone, with a slender shaft and dilated at each end. The proximal end is expanded and flattened antero-posteriorly and articulates on a distinct facet on the outer condyle of the femur. The distal end is flattened in the opposite direction to the upper and has a large convex articulation for the outer side of the proximal tarsal bone. The total length of the bone is 206 mm. The proximal end measures 63 mm. by 36 mm., and the distal end 68 mm. by 42 mm. The shaft is 27 mm. in diameter.

Proximal Tarsal Bone.

The proximal tarsal bone, which certainly represents the conjoined tibiale and fibulare with possibly the intermedium, is of the well-known Pareiasaurian type.

The Pose of the Limbs.

Though most of the bones of *Pareiasaurus* have been known for twenty years, and though four skeletons are now known from South Africa, and at least as many from Russia, there are still a good many points in dispute in regard to the pose of the animal. Seeley had the British Museum specimen mounted with the limbs so bent that the abdomen must have been almost touching the ground, with the interclavicle in advance of the plane of the occiput, and with the scapula pointing almost directly backwards. Amalitzky has set up his skeletons with the limbs straighter, with the scapula directed as much upwards as backwards and with the shoulder girdle situated some little distance behind the head. In giving a restoration of *Pareiasaurus* in 1903 from the South African Museum specimen, I also placed the shoulder girdle a little distance behind the head, and made the animal stand well off the ground. Boulenger, in discussing *Telerpeton* in 1905, criticised my restoration, pointing out that in his opinion *Pareiasaurus* had no more neck than a Salamander.

The very perfect bones of *Propappus*, though they may leave a little doubt on a few points, enable us to have a much clearer idea of the pose of the animal and of its movements than was previously possible. As all the limb bones have their articular surfaces perfectly preserved, we can fit the limbs together with certainty.

The peculiarly shaped glenoid cavity, with its large posterior concavity and the small anterior flattened surface, so exactly corresponds to the head of the humerus if we allow for a cartilaginous pad that we can articulate the humerus on the shoulder girdle with confidence, and the position of the bones when the animal is standing must be as shown in the figures given. The movement of the humerus must have been practically limited to an up and down direction, and when the animal lay down on its front the anterior limbs would lie outwards and forwards by its sides. In the standing position the humerus, radius, and ulna would be in the positions shown in the drawings. One interesting thing about the anterior limb is that it becomes quite manifest that the scapula must have been directed much more upwards than backwards, and as the shoulder girdle is about twice as long as the head is deep it cannot have been situated close up to the head, and therefore *Pareiasaurus* and *Propappus* must be regarded as having had distinct necks.

The hind limb was probably more freely movable than the

anterior, but the movement was mainly between the femur and the innominate. The head of the femur must have had a large rounded pad of cartilage which fitted into the acetabulum, and allowed of considerable freedom of movement. In the knee-joint the amount of movement must have been very limited. Both femur and tibia doubtless had articular cartilages, but the evidence is that these were comparatively thin, and the articular surfaces of the femur are not larger than those of the tibia. It seems probable that the amount of movement of the tibia on the femur was limited to about 45°. The relative positions of the femur, tibia, fibula, and the proximal tarsal bone when the animal is standing are shown in the figures given. The degree of movement between the tarsal bone and the tibia and fibula was probably very limited, and the ankle movement must have been mainly between the distal tarsals and the proximal tarsal bone.

Pareiasaurus and *Propappus* were heavily built animals which probably walked with slow, deliberate movements such as we see in the large tortoises. They were land animals, and it seems more likely that they lived even on the dry land than that they frequented the marshes. The structure of the claws and the humerus would seem to indicate that they were digging animals, and probably, like *Echidna*, they defended themselves from their carnivorous enemies by digging into the ground. The occurrence of bony plates along the dorsal region of *Pareiasaurus* would serve to protect the most vulnerable part of the body when the animal had dug its way into the ground for safety. In *Propappus*, a smaller and feebler animal, bony plates were situated all over the back and sides and apparently even on the outer sides of the limbs, but the plates on the back are very much larger and strengthened by a powerful median boss in each.

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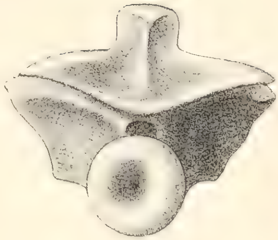

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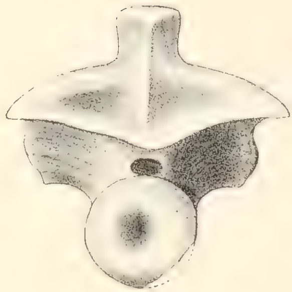

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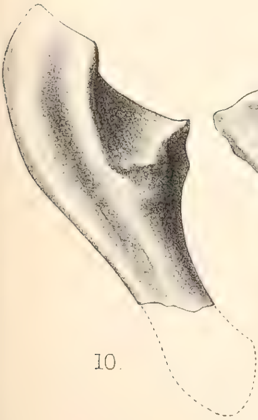

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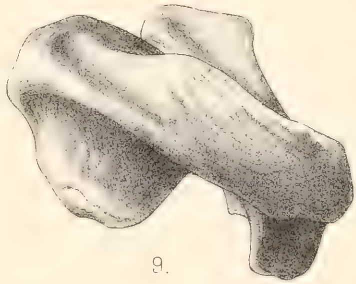
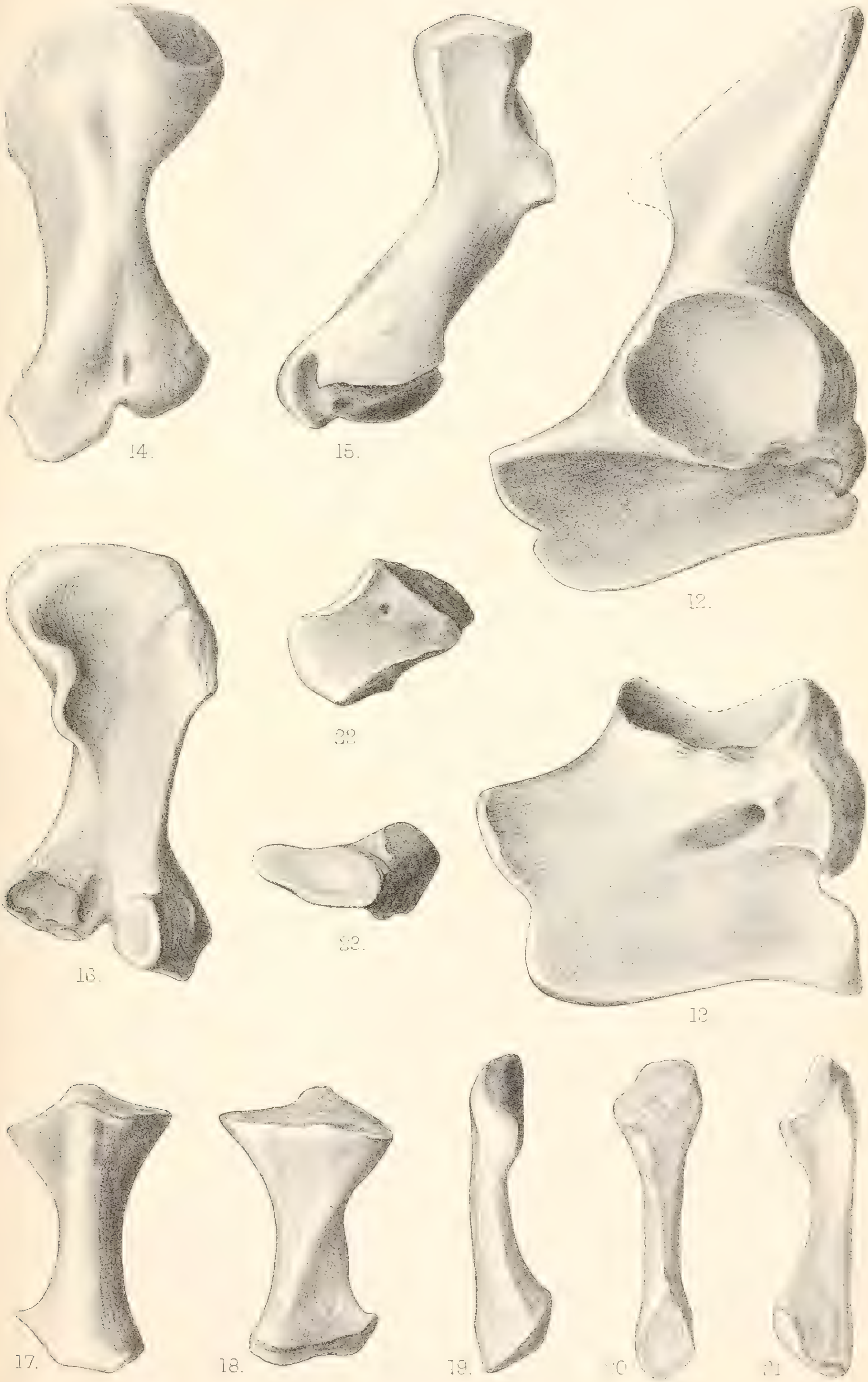


9.

R. Broom del. West, Newman lith.

Propappus rogersi, *Broom*.



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Propappus rogersi, *Broom*.

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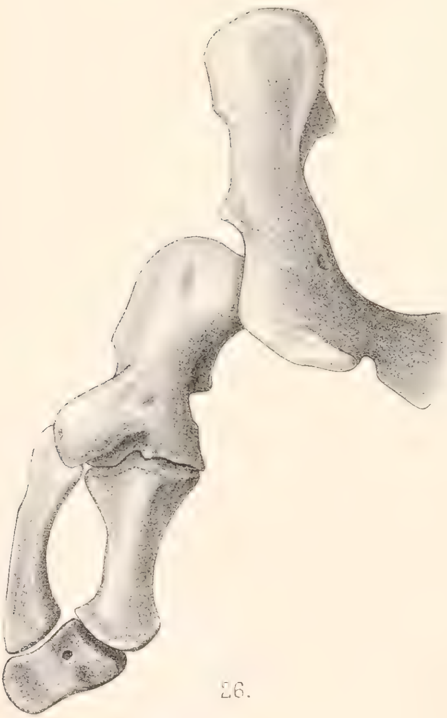

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27.

R. Broom del. West, Newman lith.

Propappus rogersi, *Broom*.

REFERENCE TO PLATES XIX., XX., XXI.

FIG.

1. Dorsal vertebra of *Propappus rogersi*. $\times \frac{1}{4}$. Posterior view.
2. ,, ,, $\times \frac{1}{4}$. Side view.
3. Lower dorsal vertebra of *Propappus rogersi*. $\times \frac{1}{4}$. Posterior view.
4. ,, ,, $\times \frac{1}{4}$. Side view.
5. Right shoulder girdle of *Propappus rogersi*. $\times \frac{1}{4}$.

6, 7, 8, 9. Right humerus of *Propappus rogersi*. $\times \frac{1}{4}$.

10. Right ulna of *Propappus rogersi*. $\times \frac{1}{4}$.

11. Right radius of *Propappus rogersi*. $\times \frac{1}{4}$.

12. Right pelvic bones of *Propappus rogersi*. $\times \frac{1}{4}$.

13. Right pubis and ischium of *Propappus rogersi*. $\times \frac{1}{4}$.

14, 15, 16. Right femur of *Propappus rogersi*. $\times \frac{1}{4}$.

17, 18. Right tibia of *Propappus rogersi*. $\times \frac{1}{4}$.

19, 20, 21. Right fibula of *Propappus rogersi*. $\times \frac{1}{4}$.

22, 23. Right tarsal bone of *Propappus rogersi*. $\times \frac{1}{4}$.

24. Right fore limb of *Propappus rogersi* viewed from the front with the bones arranged as they were when the animal stood. $\times$ about $\frac{1}{6}$.

25. Side view of fore limb of *Propappus rogersi* in the standing position.

26. Front view of hind limb of *Propappus rogersi*. $\times$ about $\frac{1}{6}$.

27. Side view of hind limb of *Propappus rogersi*. $\times$ about $\frac{1}{6}$.

16.—*On a Species of* Tylosaurus *from the Upper Cretaceous Beds of Pondoland.*—By R. Broom, M.D., D.Sc.

(Plate XXII., Figs. 28–29.)

About ten years ago a collection of bones was made from the Cretaceous beds of Pondoland by Dr. Rogers and Professor Schwarz. The bones were for the most part fragmentary and water-worn, and, except in one or two instances, detached. As was recognised at the time, all the bones found represent portions of the skeletons of Chelonians and Pythonomorphs. In the Annual Report of the Geological Commission for 1901, p. 41, the bones are referred to as jaw-bones of a reptile related to *Mosasaurus* and Chelonian bones. Recently the collection was placed in my hands to see if I could make anything further of the remains. Most of the bones are fragments of the carapace of Chelonians with other bones of the skeleton. The fragments, however, are too imperfect to justify one in deciding on the species. There are pretty certainly two species and probably three represented. One is of large size—possibly with a carapace 6 ft. in length : one is a quite small turtle less than a foot in length.

The Pythonomorph remains are more satisfactory, as not only are there some jaw fragments with teeth, but a satisfactory portion of the frontal region of the skull.

The skull fragment consists of the nearly perfect frontal bone with about the anterior half of the parietal and portions of both postorbitals.

The frontal is a large triangular bone, measuring 304 mm. in greatest length and 234 mm. in greatest width. The upper surface is moderately flat and smooth. Near the parietal suture in the middle line the bone is slightly depressed, and also in front where it meets the prefontals. The anterior end of the bone is more rounded than in any frontal I have seen figured, as if the nostrils were wider apart than usual, and as if there might have been distinct nasal bones

present. From the anterior end to the outer corner of the bone the margin of the bone is almost in a straight line. The line of the suture with the postorbital is not unlike that of *Tylosaurus proriger*. The fronto-parietal suture is more like that of *Mosasaurus horridus*. The under surface of the bone has the sides for the articulation of the postorbitals behind, of the prefrontals in front. Down the middle of the bone in the centre region is a well-marked groove.

The postorbital only has its frontal portion preserved. As preserved it agrees pretty closely with that of *Tylosaurus proriger*, but is more slender.

The parietal has a broad upper surface exactly as in *Tylosaurus proriger*, and in this differing markedly from *Mosasaurus*. The present species differs from *T. proriger* in that the pineal foramen is well behind the plane which passes through the front of the temporal fossa.

The illustrations given show the contour of the bones, and that it is pretty safe in concluding that the South African form belongs to the genus *Tylosaurus*. It is manifestly not *Tylosaurus proriger*, Cope. If v. Huene has rightly referred the species recently described by him to *Tylosaurus dyspelor*, Cope, then the South African species is a very near ally. But as it differs in that the frontal is relatively shorter, and in a number of other points, I propose to call the Pondoland form *Tylosaurus capensis*.

PLATE XXII.

FIG.
28. Upper view of frontal and parietal regions of skull of *Tylosaurus capensis*.
29. Under view of ditto.

Both $\frac{1}{5}$ nat. size.

17.—*On a New Type of Cynodont from the Stormberg.*—By R. Broom, M.A., D.Sc.

(Plate XXII., Figs. 30–36.)

Among the specimens recently placed in my hands for determination, by the Director of the South African Museum, is a most insignificant-looking fragment of a small skull bearing a number of teeth most of which are broken; but small and imperfect as it is, it is one of the most interesting finds made within recent years. The fragment was picked up by Dr. M. Ricono at Paballon, Mt. Fletcher District, Griqualand East, and given to Mr. Schwarz, of the Geological Survey, in 1902, by whom it was placed in the collection of the South African Museum.

The fragment consists of a large portion of the left maxilla with the roots of 7 teeth and two immature but perfect teeth, portion of the left jugal, and a fragment of the left palatine, of a small Cynodont reptile.

The maxillary bone as preserved measures 25 mm. in length, but there is probably at least 10 mm. missing from the front. The tooth-bearing portion is narrow and deep and extends behind the origin of the jugal arch. The jugal arch is extremely massive and the maxilla sends a process outwards to strengthen the front of it. At the front of the base of this process is a well-marked maxillary foramen towards which the sides slope in. The depth of the maxilla in the plane of the foramen is 15 mm. There is clear evidence of a well-developed secondary palate.

The jugal is unusually robust. It passes well inwards behind the outward process of the maxilla, and forms the margin of the orbit. In the suture between the jugal and the lachrymal there is a foramen probably for a branch of the maxillary nerve. No part of the lachrymal is preserved.

The teeth are apparently all similar, to judge from the roots. It is unfortunate that almost all the teeth are broken off below

the crown, except in the case of two teeth which are evidently immature. The eight teeth in front measure 17 mm., and each tooth has a section measuring 4 mm. by 1·7 or 1·8 mm. It will thus be seen that the molar series consists of a series of antero-posteriorly compressed teeth closely set together. Behind the 8 teeth more or less satisfactorily preserved is a fragment of the root of a ninth. The fifth tooth as preserved has the crown in perfect condition owing to its being immature, and the crown of the eighth is also preserved except for the loss of the tip of the main cusp. In structure the crown is unlike that of any tooth ever previously described, so far as I am aware. There is one large sharp-pointed cusp near the middle of the crown, and on its inner side a second small cusp and a third still smaller. A very small fourth cusp lies in front of the third. If the crown of the tooth were found detached, and one did not know that it was compressed antero-posteriorly, one would readily believe it to be the premolar of some primitive mammal or of some Cynodont such as *Galesaurus*.

The present specimen is so entirely unlike any form previously discovered that it is very difficult to discuss its affinities. The first question that arises is whether the animal is a mammal or a Cynodont reptile. There is, I think, little doubt that it is one or other. The teeth are single-rooted, though of course this character is of little importance. But the crowns have nothing the least like them in any of the known mammalian orders. Antero-posteriorly compressed teeth are not at all rare, as in *Chysochloris*, *Notoryctes*, *Kurtodon*, *Dryolestes*, and other genera, but these teeth are entirely different in structure from those of the present fossil, and are merely modifications of the ordinary early mammalian type. The branching of the maxillary nerve before opening on the face is also a character unknown in mammals, but met with in Cynodonts. In Cynodonts we get antero-posteriorly compressed teeth in *Bauria*, *Trirachodon*, and *Ælurosuchus*, but none of these genera can be at all nearly related to the present one. In *Bauria* the crowns of the teeth are apparently smooth and rounded, and the relations of the teeth to the jugal arch and the general structure of the maxilla and jugal are quite unlike. *Trirachodon* has molars of a highly specialised type. Each may be described as having a crown with three cusps arranged in a transverse row and connected by a low ridge, while the inner and outer large cusps are connected by a series of very small cusps arranged round the anterior and posterior borders of the tooth. It is possible that the three cusps in the present fossil are homologous with the three transverse cusps in the molar of *Trirachodon*, and

that the *Trirachodon* molar is related to that of the Stormberg fossil in much the same way that the molar of the pig is related to that of the opossum, but it seems impossible that the two animals can be more nearly related than an ungulate and a marsupial.

If this new form is a mammal it must be regarded as the representative of a new order, and if, as I believe, it ought to be regarded as a Cynodont, it will have to be the representative of at least a new family.

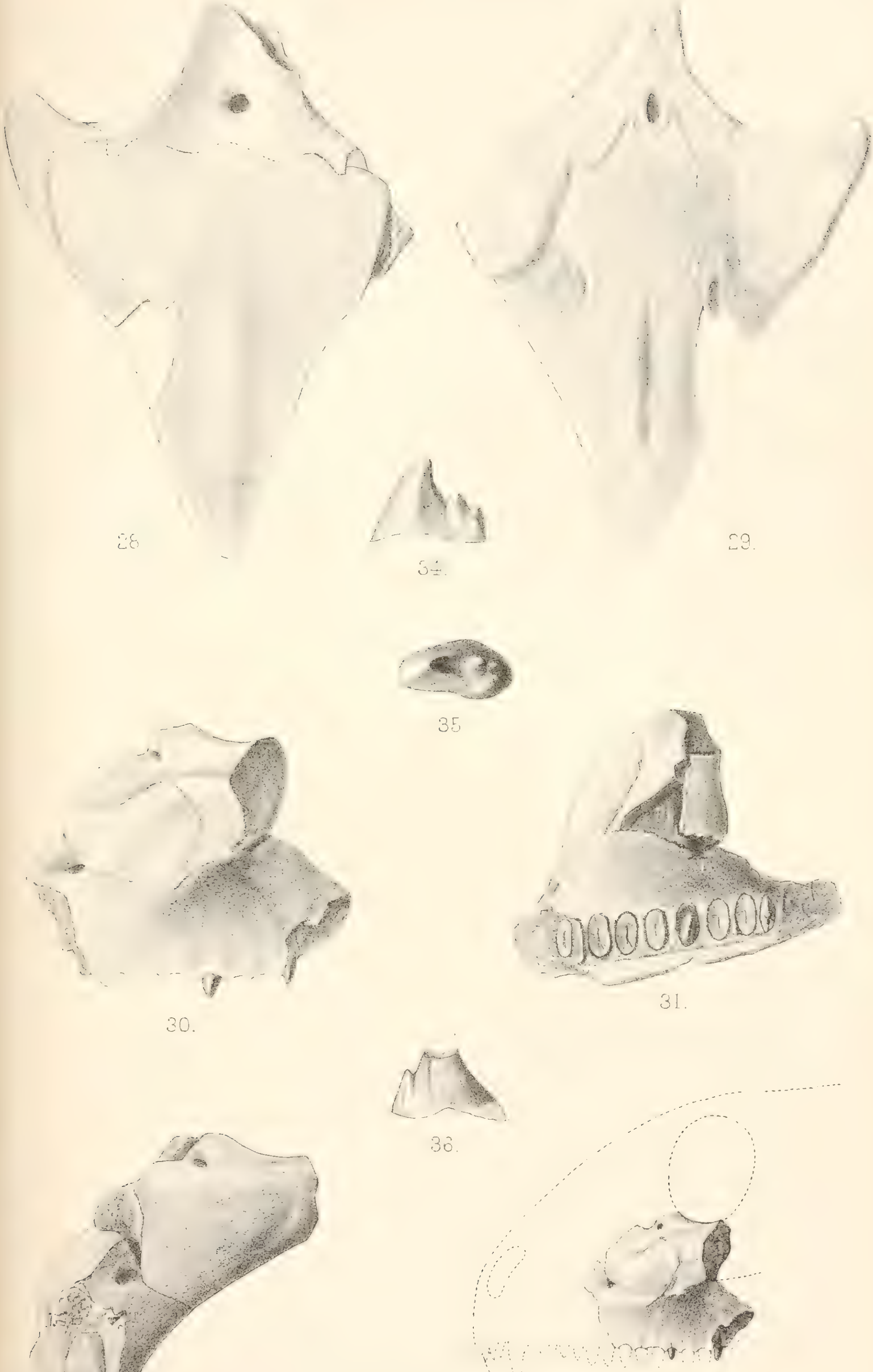
The exact horizon of the fossil is unknown. Professor Schwarz writes me that Paballon might mean any horizon from Molteno Bed to the Cave Sandstone, but from the matrix of the fossil it seems highly probable that it comes from the Red Beds. In any case it may be regarded as certain that the fossil is of Lower Jurassic age. This is interesting from the fact that no Cynodont has hitherto been got from beds younger than the Burghersdorp or Upper Triassic.

I suggest for this interesting fossil the name *Tritheledon riconoi*, g. et sp. nov., and the new family of which it is the type may be called the *Tritheledontidæ*.

PLATE XXII.

FIG.

30. Side view of fragment of the skull of *Tritheledon riconoi.* × 2.
31. Palatal view of fragment of skull of *Tritheledon riconoi.* × 2.
32. Front view of ditto. × 2.
33. Restoration of front of skull of *Tritheledon riconoi.* Nat. size.
34. Anterior view of molar tooth of *Tritheledon riconoi.* × 6.
35. Palatal view of molar tooth of *Tritheledon riconoi.* × 6.
36. Posterior view of posterior molar of *Tritheledon riconoi.* × 6.



R. Broom del. West, Newman lith.

Fig. 28-29 Tylosaurus capensis, *Broom.*
Fig. 30-36 Tritheledon riconoi, *Broom.*

18. — *On Some Points in the Structure of the Dicynodont Skull.*— By R. Broom, M.A., D.Sc.

(Five Text Figs.)

The skull on which most of the following observations are based was found on Rhenoster Fontein, a farm at the top of the Molteno Pass north of Beaufort West, and brought to the South African Museum by Dr. Kolbe. It was sent in 1902 to Prof. Seeley, and the matrix was most carefully removed under his direction by the British Museum preparators. He had most carefully examined the skull and traced out the sutures, and intended to give a full description, and had prepared for his paper a series of process blocks of drawings of the skull; but apparently he had not gone further. Doubtless other work which he thought more important, such as the study of the skull of *Erythrosuchus*, came to hand, and death overtook him with his work unfinished. The skull has been returned to the South African Museum, and as the illustrations have been prepared I have been asked to write a description of the skull to accompany the blocks. Though Prof. Seeley has left no manuscript, so far as I am aware, it is possible to get a good idea of his views from his determinations on the figures. In a number of points my views differ from those of Seeley, and where this is the case I shall give his views as well as my own.

Though imperfect as regards the right zygomatic arch and slightly crushed and distorted, it is the finest Dicynodont skull that has ever been obtained. Others have been got more complete but owing to the condition of the bone or matrix it has been impossible to display the bones in such perfection, and no skull has ever shown so many sutures satisfactorily.

As regards the species there is here, as with all Dicynodonts, an element of doubt. In the first place, we do not yet know whether *Oudenodon* is not really the female of *Dicynodon*. Owen, Lydekker, and the writer have all considered the question, and all come to the conclusion that probably the genera are distinct, but as time goes on doubts became greater, and at present the evidence on the two sides is about evenly balanced. *Lystrosaurus* is apparently tusked in both males and females, while *Cistecephalus* is tuskless in both

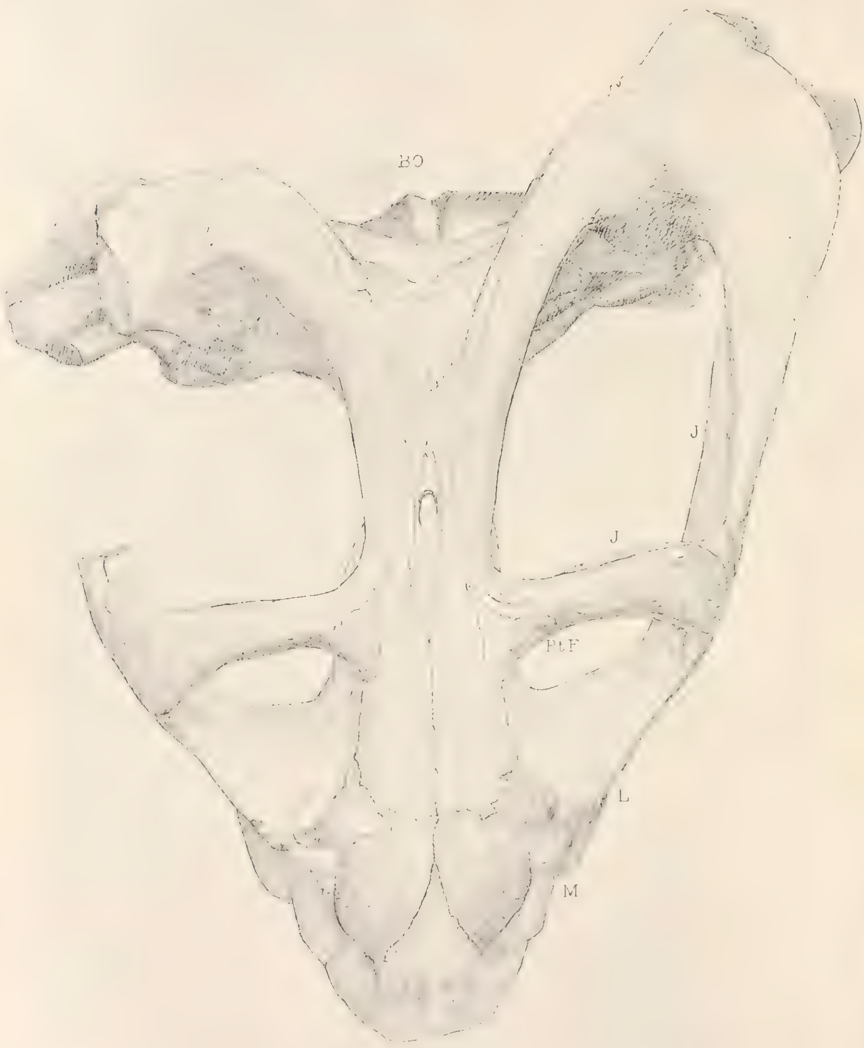


Fig. 1.—*Oudenodon kolbei.* Upper View of Skull. × ½.

sexes; but I know of no characters other than the presence or absence of tusks to distinguish *Dicynodon* and *Oudenodon*. The arrangement of bones and sutures, even to minute details, appears to be identical. Then the difficulty of determining the species is enhanced by the fact that many of Owen's types are indeterminable, since the points which appear to be most variable and on which species might be distinguished are often lost from the types.

The present specimen I have compared with all the known determinable species of *Dicynodon* and *Oudenodon*, and conclude that it is distinct from all previously described species. It approaches a number in various ways, but only with three species might it be confused. *Oudenodon baini*, Owen, agrees with it fairly closely, but differs in having the tusk-like maxillary process passing more downwards, and in having the parietal region considerably wider than the frontal, besides in a number of minor characters. *Oudenodon prognathus*, Owen, differs in the peculiar manner in which the prominent ridge of the maxilla is directed forwards and in the smaller size of the nasal bosses. *Oudenodon brevirostris*, Owen, differs in the contour of the frontal and parietal regions.

As the species is evidently new, I should have been delighted to have named it after Prof. Seeley, who has done so much valuable work on the South African fossil reptiles, but unfortunately Broili has recently associated Seeley's name with *Dicynodon*, and a species which is certainly synonymous with one of Owen's types. Some years ago a number of fossil bones were got near Middelburg and sent to the South African Museum. Dr. Corstorphine, who, as director of the Geological Survey, had charge of the specimens, thought evidently there would be no harm in sending a few of the bones to Europe, but fortunately he kept the skull. The bones sent to Europe included a beautiful pelvis, but why any European palæontologist should think of making a pelvis of an Anomodont the type of a new species passes my comprehension. At the best it could only cause confusion. In this case, fortunately, we know the skull, and it is identical with Owen's *Ptychognathus boops*. Whether *Ptychognathus boops* is itself a synonym of *Dicynodon murrayi*, Huxley, it is at present impossible to say, but quite certainly *Dicynodon seeleyi*, Broili, is not a new species. As the present skull cannot be called after Prof. Seeley, I propose to name it after Father F. C. Kolbe, D.D., who has taken such a prominent part in educational and scientific work at the Cape and to whom we owe the skull, and to call it *Oudenodon kolbei*.

The general shape of the skull is shown in the figures when

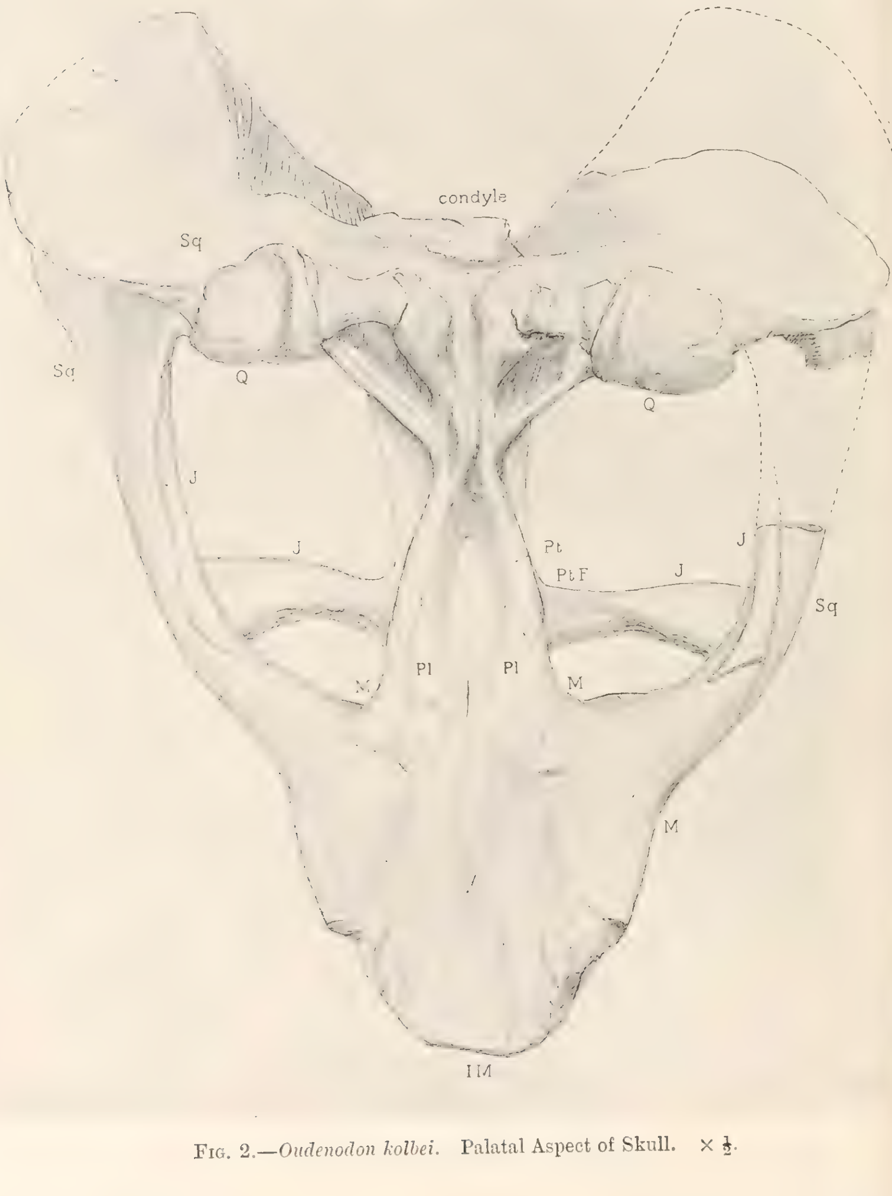


FIG. 2.—*Oudenodon kolbei*. Palatal Aspect of Skull. × ½.

allowance is made for some degree of depression of the frontal and parietal regions. But though the outlines are moderately correct, the shading is very unsatisfactory. In Fig. 2 the deep vaulting of the front of the palate is not shown, nor is the deep depression between the anterior parts of the pterygoids brought out, nor the deep furrow between the basioccipital processes. In Fig. 1 there is very little attempt to indicate the heights and depths of the specimen. Figs. 3 and 4 are both fairly well drawn, but the shading bad in both, especially in Fig. 3.

The premaxillary (IM, intermaxillary in the figures) is a large powerful median bone. In all the Dicynodonts the bones of the two sides are anchylosed at a very early period. In front the bone forms a rounded sharp beak. Above a broad powerful internasal process passes up between the nasals and ends in a point as shown in Fig. 1. Underneath the premaxillary forms about two-thirds of the hard palate. Though the suture is not shown in the figures, it begins in the dark mark shown in Fig. 3 behind the letter " b " of " broken," and passes almost straight back along the outside of the irregularities believed by Seeley to be teeth. It then passes inwards in front of the irregularity marked "palatine tooth," and ends in the middle line in front of the irregularity marked " tooth," and behind the region marked " teeth lost." I have carefully examined the structures regarded by Seeley as teeth, and am quite satisfied they are merely bony irregularities with no tooth structure. The whole of the hard palate was probably covered by thick epithelium, which was horny in front, and probably most of the snout above was also covered with a horny beak and horny scales. Underneath the great epithelial development the bone in most places is irregular. The nasals, the premaxilla, and much of the external surface of the maxillæ have a very rough appearance. In the palate there are patches of what appear to me to be exactly the same style of roughened bone. This rough appearance is seen on the median ridge formed by the premaxilla and on the small part of the ridge formed by the vomer on the pair of ridges in the front part of the premaxillary, on the ridges formed by the lateral margins of the premaxillary, and on the anterior part of the palatines. Though it is customary to speak of the horny beak of the Anomodonts, it is probable that the beak was less horny than in the tortoise or bird, except perhaps just on the margins.

Both maxillæ are in almost perfect preservation; that of the left side being quite perfect except for the loss of a minute fragment from the caniniform process. The bone forms the greater part of

the side of the snout behind the large nostril. A stout suborbital process articulates with the jugal and meets the anterior end of the huge squamosal. On the palate the maxilla is overlapped by the premaxilla, and only forms a small part of the roof of the mouth, though each maxilla forms about one-third of the margin of the palate. Posteriorly the maxilla meets the palatine, and much of it is covered by the jugal.

Fig. 3.—View of Front of Palate. Nat. size.

Showing appearances regarded by Seeley as teeth. By the writer these are believed to be merely irregularities on the surface of the bones.

The nasal is comparatively short. It forms an overhanging roof to the nostril, and a considerable part of the posterior wall. It meets its neighbour only for a very short distance near the frontal bone, the two nasals being nearly completely separated by the internasal process of the premaxilla. Above and a little behind the nostril there is a well-marked bony thickening slightly exaggerated in Fig. 1.

On the posterior wall of the nostril there is a small bone which appears to be quite distinct from both the maxilla and the nasal, and which is evidently a small septomaxillary. Hitherto a septomaxillary has not been detected in any Anomodont, though it is known in all the other groups of mammal-like reptiles—Cynodontia, Therocephalia, Dinocephalia, Dromasauria, and Pelycosauria—as well as in the Cotylosaurian suborders Pareiasauria and Procolophonia and in the Monotremes.

The lachrymal has a comparatively small facial portion, though it forms a considerably larger part of the orbital wall. The foramen is rather large and lies inside the orbit.

The prefrontal is a little larger than the lachrymal, and forms the anterior part of the supraorbital ridge. It also forms a considerable portion of inner wall of the orbit.

The frontals are paired elongated bones which form most of the interorbital region, and pass back as far as the pineal foramen. Though the suture between the frontals and the nasals is not very clearly defined, owing to the thickening of the bones, it is probably very nearly as determined by Seeley. Posteriorly the frontals become very narrow as they pass back between the preparietal and the postfrontal and postorbital. The suture between the frontals and the parietals is on the plane of the front of the pineal foramen. The line indicating a supposed suture in front of this in Fig. 1 is an error. Where the frontals meet each other there is a slight median ridge, and the orbital margins are considerably elevated, leaving a pair of fairly deep furrows along the frontal bones. On the upper side of each bone opposite the middle of the orbit are a pair of short grooves which end in foramina, most probably for branches of the supra-orbital branch of the Vth nerve.

The postfrontal bones can be very clearly defined for the first time in a *Dicynodon* or *Oudenodon* skull. They were known to occur in *Lystrosaurus*, in a number of Therocephalians and in Dinocephalians and Pelycosaurs, but they are lost in all Cynodonts, and were hitherto believed to have been also lost in *Dicynodon* and *Oudenodon*. The part that now proves to be a distinct postfrontal bone was hitherto regarded as a part of the frontal, the suture being usually indistinct or lost. In Fig. 1 the two postfrontals are well shown as small triangular bones situated at the posterior and upper corner of the orbit. On the posterior side of each is the postorbital and on the inner side the frontal. In my opinion the postfrontals extend further back than indicated in Fig. 1, as delicate processes by the side of the frontals.

The postorbitals are large bones which form almost the whole of the inner wall of the temporal fossa and the greater part of the post-orbital arch. This large bone used to be regarded as the postfrontal (Seeley 1889, Broom 1901, 1903), but the discovery of a small but distinct bone in front of it in *Scylacosaurus* in 1903 showed that the large bone must be called the postorbital, the small more anterior one being manifestly the postfrontal. Exactly what Seeley's position in the matter was latterly I cannot say. In

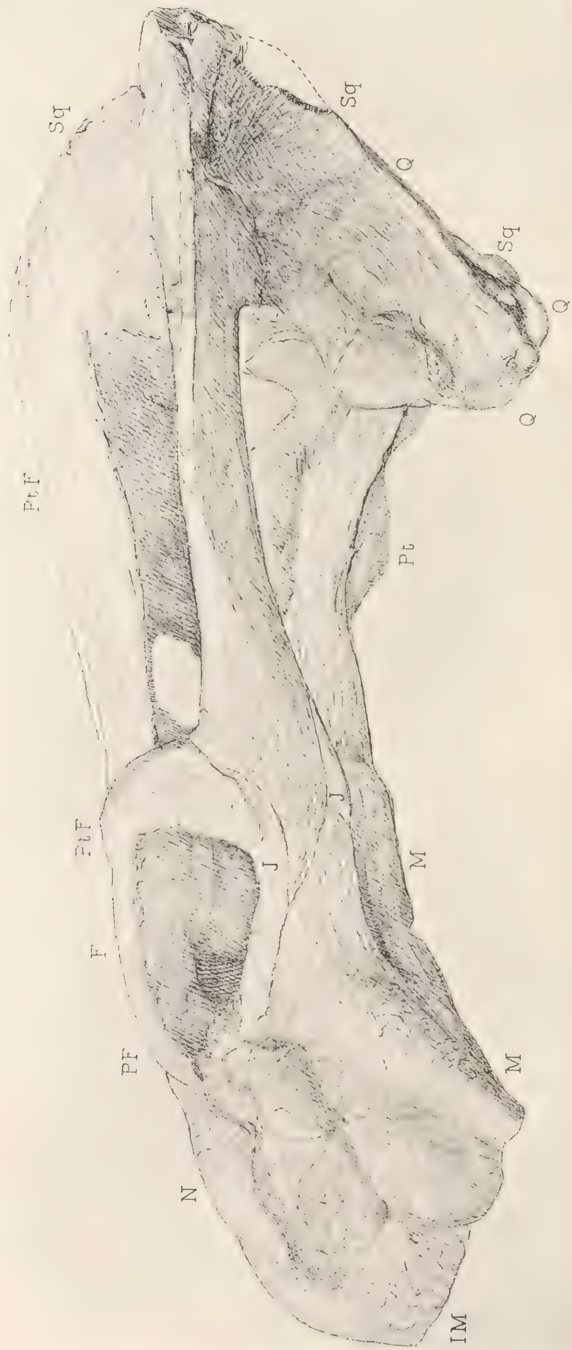


Fig. 4.—*Oudenodon kolbei.* Side View of Skull. About $\frac{3}{5}$ nat. size.

Fig. 1 he has the postfrontal carefully marked PtF, and the postorbital is left unlettered, but in Fig. 4 he has both the postfrontal and the postorbital marked PtF. Probably the lettering of the latter bone is a *lapsus calami*. The postorbital arch is formed by three bones—the postfrontal forming a small part of the upper end, and the jugal forms the whole of the inner side of the lower half. At the upper end of the postorbital arch the postorbital passes backwards on the outside of the parietal and at the posterior end overlapping the squamosal.

The jugal is a large bone which is developed in three different directions. The anterior part forms the lower wall of the orbit and the greater part of the suborbital arch. It is overlapped by the maxilla and articulates with the lachrymal and with the palatine. It sends up a strong flat process behind the orbit and articulating with the under side of the postorbital portion of the postorbital bone. The posterior process of the jugal extends back nearly as far as the temporal fossa, and lies along the inner side of the zygomatic process of the squamosal.

The large pineal foramen is situated a little behind the plane of the postorbital arches. It is in the middle of a median bone which has been called the preparietal. This bone is present in most Anomodonts, but is absent in *Cistecephalus*. It is unknown in any other order of reptiles. By Newton it is believed to be the interparietal, but this is pretty certainly wrong. One might consider whether this is not the true parietal, and the supposed parietals modified post-temporals, but from the condition in Therocephalians and in *Cistecephalus* we may safely conclude that the parietals are rightly identified. The preparietal is a narrow bone only a little wider than the foramen, and there is about two-thirds of the bone in front of the foramen and only one-third behind.

The parietals are a pair of greatly elongated narrow bones. In front they articulate with the frontals, and, passing backwards between the preparietal and the postorbitals, form the median portion of the post-temporal ridge, and articulate with the squamosals. Though when viewed from above the parietals are very narrow, this is owing in part to their being covered by the postorbitals.

Behind the parietals is a large median bone which is greatly developed laterally, and forms the back of the temporal ridges. This is the bone which has usually been called the interparietal, and whether or not it may be the homologue of one or other of the membrane bones of the lower forms, it seems highly probable that it is

homologous with the mammalian interparietal, and therefore rightly named. It articulates with the whole of the posterior end of the parietals, and even extending beyond them supports part of the squamosal.

The squamosal is by far the largest bone in the skull. The posterior part articulates with the exoccipital and supraoccipital, and is also supported by the interparietal. The downward portion which is supported by the exoccipital has attached to its lower end the quadrate, and to the front of the plate the large quadrato-jugal. The upper and inner portion of the squamosal passes inwards and forwards as a narrow plate which rests on the interparietal and on the parietal, and its most anterior part is covered by the postorbital. The zygomatic portion passes directly outwards from near the top of the main portion of the bone, and then curves forwards

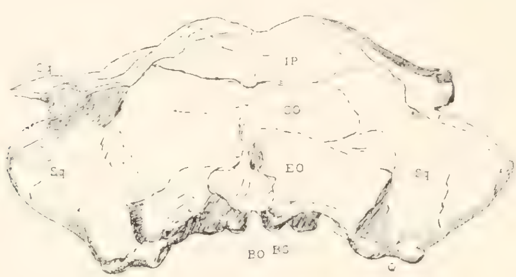


Fig. 5.—Occiput of *Oudenodon kolbei*. About ⅓ nat. size.

and ends in a point below the orbit. The greater part of the zygomatic process rests on the jugal, and the extreme anterior end is in contact with the posterior part of the maxilla.

The question of whether the Anomodonts have or have not a quadrato-jugal is one which has occupied my attention for the last ten years, and every skull with the articular region at all well preserved has been most carefully examined for further light on the matter. The large flat plate which rests on the front of the lower part of the squamosal has the appearance of a membrane bone, and had any suture been found between it and the articular head it would at once have been determined as a quadrato-jugal; but in the most perfect specimens hitherto examined it was quite clearly made out that the articular end was the same bone as the flat ascending plate, and the whole was thus believed to be quadrate. Further, there quite certainly was no quadrato-jugal bone in the Cynodonts, and none seemed to be present in the Therocephalians; it was thus

unlikely that one should be found in Anomodonts. The study of the Pelycosaurs showed that the American mammal-like reptiles are allied to the South African, though in general structure rather more primitive, but there is certainly a quadrato-jugal in the Pelycosaurs. We now know that in the South African Dinocephalians *Delphinognathus*, *Tapinocephalus*, and *Moschops* there is also a well-developed quadrato-jugal. Recently I have discovered that a quadrato-jugal is present in *Endothiodon*, and as *Endothiodon* is a near ally of *Dicynodon*, though rather more primitive, the discovery has compelled me to still more carefully examine the condition in *Dicynodon* and *Oudenodon*, and the skull of *Oudenodon kolbei* gives the opportunity desired.

In *Endothiodon* the large plate which rests on the squamosal is evidently all quadrato-jugal, and the present skull proves that in the Dicynodonts this large plate is also quadrato-jugal. The difficulties have arisen from the fact that about the outer third of the articular end, and which has always been regarded as quadrate, now proves to be quadrato-jugal. The articular surface is of irregular quadrangular shape, of which the outer two-thirds are slightly convex and the inner third has an antero-posterior ridge. Though all this surface looks as if it were one bone, the quadrate, it is found that a delicate suture runs across the outer convex portion in an antero-posterior direction, dividing the surface into two. The outer portion, which is little less than half, is quadrato-jugal, the inner is quadrate.

The quadrato-jugal bone thus consists of an articular end and a large flat plate affixed to the anterior side of the squamosal. There is probably a passage between the quadrate and the quadrato-jugal, as in most reptiles.

In connection with this discovery it is interesting to note that Dr. Goodrich came to the correct conclusion a good many years ago, as appears from a letter he sent me in 1903, in which he says: "I was much interested to hear that you had succeeded in working out the jaw articulation in Theriodonts, but I am still uneasy about the identification of the bones of this region in the Dicynodonts. Some time ago I made some notes in the British Museum, and concluded that on the outer and anterior face of the squamosal there is a bone with an upper squamous blade spreading over the squamosal and a lower portion sharing to a small extent in the formation of the articulation for the lower jaw. This bone is, I believe, the one you call quadrate. But since it has more the appearance of a membrane bone—is apparently on the outer surface alone and does not come into relation with the bones of the auditory

capsule—it seems to me more like a quadrato-jugal," and further, "I should like to suggest that the quadrate must be sought somewhere proximally to my quadrato-jugal." Though Goodrich failed to identify the quadrate, and to clearly understand the articulation, he deserves full credit for having been the first to correctly identify the quadrato-jugal. From the determinations on Fig. 4 it is manifest that Seeley regarded the quadrato-jugal as part of the quadrate, as has been my own opinion till now.

The quadrate forms the inner portion of the articular surface. It is a moderate-sized bone, which is supported by the squamosal but also partly by the exoccipital, and largely by the quadrato-jugal. On its inner side it gives support to the dumb-bell shaped bone which I hitherto believed to be the tympanic, but which now proves to be the stapes.

The vomer is not perfectly displayed in the specimen, but its structure is well known in other specimens. It articulates with the premaxilla in front and forms a short backward continuation of the premaxillary median ridge. It divides the posterior nares, and, passing backwards, spreads out, and, with the palatine, forms a roof to the posterior nares after their union.

The palatine is a well-developed bone which forms a small secondary palate, and on passing backwards forms much of the lateral wall of the posterior nares. The palatal surface of the anterior part is roughed, as are the palatal margins and the median ridge of the premaxilla, and this rough area is regarded by Seeley as a tooth. Its situation is shown in Figs. 2 and 4. As with the other roughened patches, I feel perfectly satisfied that there is no tooth structure present and that the structure is merely a bony irregularity due to the bone having been covered by a thickened epidermal development. The parts marked M in Fig. 2 by the side of the palate, and evidently regarded by Seeley as maxillæ, are, in my opinion, also palatine, the suture shown in the figure being the boundary between the palatine and the maxilla. In Fig. 4 the notch between the two letters M is the suture, and the posterior M ought, in my opinion, to be Pl.

I can find no trace of a transpalatine.

The pterygoid is a long narrow bone which in front articulates with the palatine, being clasped by the inner and outer portions of this latter. It forms much of the walls of the posterior narial fossa. Behind the fossa the bones of the two sides firmly unite with one another below the basisphenoid, with which they form a strong suture. The carotid foramen pierces this back part of the bone

near the middle line. From the sides of this sphenoidal portion of the pterygoids there passes outwards and backwards a flattened process which extends to and articulates with the quadrate.

There is still a little uncertainty as to the structure of the epipterygoid, and the skull of *Oudenodon kolbei* does not reveal the structure satisfactorily on either side. What appears to be the condition from other specimens is as follows: There is a long slender rod-like epipterygoid or columella cranii which passes from the parietal above to the pterygoid below. At its lower end it has an antero-posterior development which is closely articulated with the side of the basisphenoid and rests on the side of the pterygoid. In front it passes forwards nearly to the palatine, and behind a considerable distance towards the quadrate.

The basisphenoid is a well-developed median bone situated between the pterygoid in front and below, and the periotic and the basioccipital behind. The anterior portion passes forwards above the pterygoids and articulates with the vomer. The posterior and middle part forms a considerable part of the strong bony framework which supports the brain. In this bony mass sutures are not usually distinct, but some can be made out with certainty and others with much probability. Laterally and posteriorly the basisphenoid articulates with the large bone which holds the ear capsule and which may be called the periotic. Between the two is a foramen for the VIIth nerve. On the undersurface the basisphenoid has two flattened processes which form anterior supports to the basioccipital processes.

The periotic is a large massive bone, and it may possibly be made up of an anterior prootic and a posterior opisthotic as in *Ophthalmosaurus*, but at present this is uncertain. It has a descending process which forms part of the basioccipital process and in it is the fenestra ovalis.

The basioccipital is relatively small. It forms the lower third of the occipital condyle and the greater part of the basioccipital processes. By the side of the condyle is a large foramen for the IXth, Xth, XIth, and XIIth nerves.

The exoccipital forms the outer third of the condyle and the large lateral process of the occiput.

The supraoccipital forms most of the upper flat portion of the occiput. In the *Oudenodon kolbei* skull the structure of the occiput is not very clearly shown, but the whole structure is known from other specimens.

In front in the middle line there is another bone which has not

yet been mentioned. This is the ethmoid. It lies under the frontal, and is badly shown in the present skull.

There remains only one other bone to be discussed, namely, the dumb-bell shaped bone lying between the quadrate and the basioccipital process. In the present skull it is beautifully shown, as can be seen in Fig. 2. Seeley has left it unnamed in the illustration, and hitherto there has been doubt as to its determination. I have long been of opinion that it was the tympanic, but I have just discovered that this is not so. There is now no doubt that the ear capsule extends down the basioccipital process and that the fenestra ovalis is situated at the side of the lower end of the process and that it is covered by the end of the bone in question. There can therefore be no longer any doubt that the bone is a true stapes. Elsewhere I shall give a detailed account of the structure of the Anomodont ear. In *Oudenodon kolbei* the stapes is, when viewed from below, a somewhat dumb-bell shaped bone, but being irregularly rhomboidal in shape it measures across the one pair of opposite angles 30 mm., and across the other pair 23 mm. Across the narrowest part of the middle it measures 12 mm. When the bone is viewed from behind it is seen to be much flattened, the middle part being only 4 mm. in thickness.

The following are the principal measurements of the skull, allowance being made for the slight distortion.

Greatest length from occipital condyle to front of beak	228 mm.
Greatest length from beak to back of squamosal	274
Width of frontal region	36
Width of skull behind postorbital bar	170
Greatest width across squamosals, about	230
Greatest width of palate	56
Length from orbit to front of beak	65
Length of orbit	55
Width at narrowest part of parietal region	35

Addendum.—Since the above was written there has appeared Prof. Jaekel's book entitled "Die Wirbeltiere," in which he gives three figures of the skull of *Oudenodon kolbei.* His interpretations of the bones agree in the main with those here given. He recognises the distinctness of the quadrato-jugal. The bone which has been called preparietal by Seeley and myself Jaekel regards as the unpaired parietal. The bones which we regard as the parietals he

does not name. He identifies what he believes to be a distinct transpalatine, and the median ridge of the premaxillary he believes to be part of the vomer. I have carefully re-examined the skull since seeing Jaekel's book, and am satisfied that this determination of the vomer is wrong, and I still think we must regard the paired bones as the parietals and the bone round the pineal foramen a neomorph. The condition of the parietals in *Cistecephalus* makes this conclusion pretty certain. Whether there are distinct transpalatines is less clear. The condition in this skull would appear to lend support to their existence, but I think the apparent sutures are due to crushing.

Later Addendum.—On one or two points which were left in doubt in the above paper definite information is now forthcoming. There is no longer any question that *Oudenodon* is the female of *Dicynodon.* The large series of specimens of *Diaclurodon whaitsi* collected by the Rev. J. H. Whaits, at Beaufort West, show that a tusk may be either present or absent, and that it is pretty certainly a sexual character. Another small Endothiodont obtained by Mr. Whaits at Lemoenfontein also shows tusked and tuskless specimens of certainly the same species. Further, at Kuilspoort, Mr. D. M. S. Watson and myself have obtained specimens of *Oudenodon bolorhinus* tusked and tuskless. The above-described specimen will thus have to be called *Dicynodon kolbei.*

There is unquestionably a septo-maxillary in *Dicynodon*, and quite a large one has been found by Mr. Watson in *Lystrosaurus.*

In *Endothiodon* there has been discovered a distinct transpalatine, and careful examination shows that in at least some specimens of *Dicynodon* it is also distinct. It is thus probable that Jaekel is right in his identification of the transpalatine.

19.—*On the Manus and Pes of* Pareiasaurus.—By R. Broom, M.D., D.Sc., F.R.S.S.Af.

The South African Museum recently obtained a fair skeleton of a large *Pareiasaurus*—probably *P. baini*, Seeley, from Hottentot's Rivier, through the kindness of Mr. Gordon. The specimen was carefully removed by Mr. A. R. Walker, who succeeded in securing one hind foot with the toes in nearly perfect condition, and one front foot, which, though most of the toes are lost, has most of the carpus preserved with the bones in undisturbed position. These most welcome additions make our knowledge of the osteology of *Pareiasaurus* almost complete.

Though the carpus is not quite complete, sufficient of the elements are found in contact to enable us to restore the whole carpus with much probability.

The radiale is by far the largest element of the carpus. It measures 111 mm. in width, 72 mm. between the distal and proximal surfaces, and 75 mm. between the palmar and dorsal surfaces. It fits into and occupies nearly the whole of the distal end of the radius. On the palmar surface there is developed a large irregular boss which probably functioned as a heel to the manus and bore the greater part of the weight. The outer side of the radiale articulates with the intermedium and the 2nd centrale.

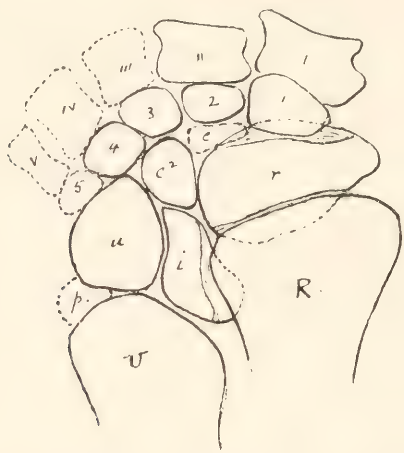
The intermedium is a narrow little bone which lies partly between the radiale and ulnare and partly between the radius and ulna. It measures 80 mm. in length, about 40 mm. in thickness, and 48 mm. between the palmar and dorsal surfaces.

The ulnare is a small bone which when viewed from above appears nearly circular. The upper surface is moderately flat and the palmar irregularly rounded. The upper surface measures 67 mm. in length and 58 mm. in width. The greatest thickness of the bone is about 35 mm.

The 2nd centrale is a small rounded bone which fits in between the radiale, intermedium, ulnare, 4th carpale, 3rd carpale, and probably the 1st centrale. It measures on the upper surface 45 mm. by 32 mm.

Of the other elements of the carpus the radial centrale is lost, the 4th carpale is in position, the 3rd only slightly displaced, and the 1st is in apposition with the 1st metacarpal, but displaced from the radiale. What is believed to be the 2nd carpale, but may possibly but much less probably be the radial centrale, is present but displaced. There is evidence of a lost 5th carpale. The metacarpal and 1st phalanx of the pollex is present, and a metacarpal which is probably that of the 2nd digit.

The 4th carpale is a moderate size element; but the upper surface is smaller than that of the 2nd centrale, measuring 38 mm. by 26 mm.



Left Carpus and adjoining Bones of *Pareiasaurus*.

The distance between the palmar and dorsal surface is about 37 mm.

The 3rd carpale is very narrow and deep. Its greatest width is 30 mm. and its depth 40 mm. The greatest measurement between the proximal and distal surfaces is 24 mm.

The element which is almost certainly the 2nd carpale is 42 mm. in width, 51 mm. in depth, and 30 mm. between the proximal and distal surfaces. The upper surface is reduced to a minimum while the under surface is flattened and doubtless bore part of the weight.

The 1st carpale has a fairly large upper surface and a small flattened lower surface. The greatest width of the bone is 47 mm. and the depth 40 mm. The distance between the proximal and distal surfaces is 32 mm.

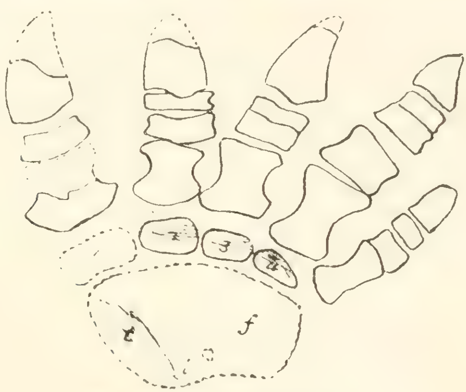
By fitting the distal elements in position the complete structure of the carpus can be seen, only the 1st centrale being lost, and its size and position being apparent.

The 2nd metacarpal is a large quadrangular bone, measuring about 42 mm. in length and 58 mm. in width.

The 1st metacarpal is an irregularly shaped bone as shown in the diagram. It measures 75 mm. in width and 46 mm. in greatest length.

The 1st phalanx of the 1st digit is a small bone measuring 56 mm. in width and 26 mm. in length.

The structure of the carpus will be seen to be of the primitive generalised reptilian type. In the highly developed amphibian



Right Pes of *Pareiasaurus.*

Eryops, the number of the elements is the same as in *Pareiasaurus*, and the arrangement fairly similar. In *Sphenodon* the same primitive structure is retained with little modification, and in the mammal-like reptiles the agreement is even more striking. In *Dicynodon* we find the same 11 elements, and except for the smaller size of the radiale the carpus might be called Pareiasaurian in type. In the Dromasauria and the Pelycosauria the same type is met with, and even in the mammals of to-day the only difference is that the 5th carpale and one of the centralia are lost, and often both centralia.

The pes, though lacking the proximal part of the tarsus, fortunately has the digits nearly complete, besides three distal tarsal elements.

The tarsals preserved are the 2nd, 3rd, and 4th. The 5th appears to have been unossified.

The 2nd tarsale measures 38 mm. by 23 mm., and has a well-marked dorsal surface. The 3rd tarsale is rather smaller, measuring 34 mm. by 22 mm., and the dorsal surface is reduced to a narrow ridge. The 4th tarsale is 34 mm. by 18 mm., and has a small but distinct dorsal surface.

The following are the approximate measurements of the metatarsals and phalanges.

		Length.	Prox. Width.
1st metatarsal		——	60 mm.
1st phalanx		22 mm.	42 ,,
Claw	about	70 ,,	48 ,,
2nd metatarsal		43 ,,	45 ,,
1st phalanx		20 ,,	40 ,,
2nd phalanx		13 ,,	40 ,,
Claw	about	60 ,,	43 ,,
3rd metatarsal		52 ,,	45 ,,
1st phalanx		23 ,,	40 ,,
2nd phalanx	about	13 ,,	40 ,,
Claw		55 ,,	43 ,,
4th metatarsal		60 ,,	40 ,,
1st phalanx		30 ,,	42 ,,
2nd phalanx...... ..		20 ,,	38 ,,
3rd phalanx		17 ,,	32 ,,
Claw		38 ,,	35 ,,
5th metatarsal		48 ,,	29 ,,
1st phalanx		22 ,,	27 ,,
2nd phalanx		17 ,,	20 ,,
Claw		28 ,,	22 ,,

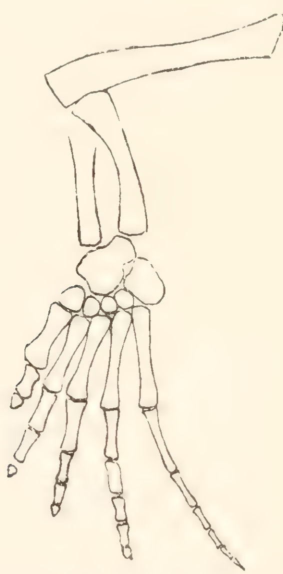
It is unfortunate that one cannot give with certainty the structure of the tarsus. All we know for certain is that the proximal elements are fused into a single bone and that there are a series of small distal tarsals. The proximal bone certainly represents at least the tibiale and fibulare, but whether there is or not an intermedium must remain at present uncertain. From a comparison with the condition in *Procolophon* I am inclined to think that the bone represents the fused tibiale, fibulare, and intermedium. There are pretty certainly 4 distal tarsals and probably a small centrale.

This foot removes any doubt there might have been as to the digital formula of *Pareiasaurus*. In the British Museum specimen the phalanges were so mixed that Seeley was unable to fix the digital formula. Amalitsky has, in a photograph of one of the

Russian specimens, shown that the formula is probably 2, 3, 3, 4, 3. In *Propappus* two adjacent toes have more than 3 phalanges, and I regarded the formula in it as probably 2, 3, 4, 5, 3. It is now pretty certain that in *Pareiasaurus* the formula is 2, 3, 3, 4, 3. It might be thought unlikely that two animals so nearly allied could have a different formula, but in the Therocephalia we almost see the change taking place from the 2, 3, 4, 5, 3 formula to the 2, 3, 3, 3, 3. In *Ælurosaurus*, though the formula at first sight appears to be 2, 3, 3, 3, 3, in reality it is 2, 3, 4, 5, 3, as there is a small plate-like phalanx beyond the 1st phalanx of the 3rd toe and two minute phalanges in the 4th toe. In *Galepus* and *Galechirus*, and in *Dicynodon* the formula is certainly 2, 3, 3, 3, 3. In *Pareiasaurus* I cannot detect any rudimentary phalanges. On the present evidence I think one may conclude that *Pareiasaurus* with its massive body and short toes represents a stage in the reduction of the digital formula, while the lighter *Propappus*, though so closely allied to *Pareiasaurus*, retains the more primitive formula of 2, 3, 4, 5, 3. Williston has recently shown that the American Cotylosaur *Limnoscelis* has a foot which is very Pareiasaurian in type but which has the formula 2, 3, 4, 5, 3–4, and this is also the formula of *Procolophon*.

20.—*On a New Mesosaurian Reptile* (Noteosaurus africanus).—By R. Broom, M.D., D.Sc., F.R.S.S.Af.

Hitherto three species of *Mesosaurus* have been recognised in South Africa—*M. tenuidens*, Gervais, *M. pleurogaster*, Seeley, and *M. capensis* (Gürich). A fourth species is known from Brazil, *M. brasiliensis*, McGregor, and from Brazil is also known an allied



Right pes of *Noteosaurus africanus*. About nat. size.

Mesosaurian, *Stereosternum tumidum*, Cope. Though *Stereosternum* and *Mesosaurus* agree in most essential characters, they differ in the former having a pubic foramen and the latter a pubic notch. In both genera the digital foramen is in the hind foot 2, 3, 4, 5, 4. The new specimen which I am about to describe is also closely allied to *Mesosaurus*, but differs in having the digital formula of the hind foot 2, 3, 4, 5, 6.

For the new type I propose the name *Noteosaurus africanus*, g. et sp. nov.

The specimen was discovered in the district of Victoria West by Mr. Blake. There is no doubt it is from the same horizon as the South African species of *Mesosaurus*. Unfortunately only the pelvic region with the anterior part of the tail and the greater part of the two hind limbs are known; and further, though the feet are satisfactorily preserved the pelvis is almost hopelessly weathered away. A part of the ischium is preserved, a fragment of the pubis, and a fair portion of the ilium. There is no evidence as to whether the pubis was perforated or notched.

The femur measures 33 mm. in length. The ends resemble those of the South African Mesosaurs rather than the Brazilian in being less completely ossified. The tibia and fibula agree rather with those of *M. brasiliensis*. The fibula has, as in that species, the typical Cotylosaurian shape. It measures 21 mm. in length, and the head is 5·3 mm. wide. The tibia is rather slender.

The tarsus is well preserved. The two large proximal elements are very similar to those in *M. brasiliensis* and *M. capensis*, the resemblance to those of the former being the more marked. Distally there appear to be only four tarsalia. The shape of the elements will be best understood from the figure.

The following are the lengths of the metatarsals and digits in this new species, and, for comparison, the lengths in the foot of the Nieuwoudtville *Mesosaurus* which is believed to be *M. capensis*.

	Noteosaurus africanus.	*Mesosaurus capensis.*
1st metatarsal	9 mm.	8·7 mm.
2nd ,, ...	12 ,,	12·4 ,,
3rd ,, ...	12·8 ,,	15 ,,
4th ,, ...	13·5 ,,	16·5 ,,
5th ,, ...	14·5 ,,	18 ,,
1st digit, incl. metatarsal	15·5 ,,	16 ,,
2nd ,, ,, ...	24·7 ,,	24·6 ,,
3rd ,, ,, ...	28·6 ,,	31 ,,
4th ,, ,, ...	33 ,,	37 ,,
5th ,, ,, ...	39 ,,	39 ,,

In comparing the feet of the two forms the most striking differences are the relatively greater lengths of the 3rd, 4th, and 5th metatarsals in *Mesosaurus*, the greater length of the 4th toe in *Mesosaurus*, and the relatively greater length of the 5th toe in

Noteosaurus. The possession of 6 phalanges in the 5th toe of *Noteosaurus* is a striking difference from *Mesosaurus,* when certainly there are only 4 in the known specimens.

The phalanges of the 6th toe are slender, and the last one is pretty certainly not clawed, whereas those of the other toes are short and probably had some sort of nail or claw.

Noteosaurus africanus is a very near ally of *Mesosaurus,* and is an interesting modification. The increase in number of the phalanges of the 5th toe is exactly comparable to the increase in the number of phalanges in the manus of the Cetacea. It is remarkable to find this modification in one of the oldest known reptiles. The zone in which it occurs is certainly not later than Lower Permian. It may even possibly be Upper Carboniferous. It is further remarkable that only one toe should be thus specialised.

21.—*A Revision of the Reptiles of the Karroo.*—By R. Broom, M.D., D.Sc., F.R.S.S.Af.

Probably no fossiliferos deposit in the world will ever compare in importance with the extensive Permian, Triassic, and Jurassic beds forming the Karroo system of South Africa. We have here the continuous record of perhaps 3,000,000 years, and as they were the years which saw the birth of all the various reptilian orders, of the birds and of the mammals, the most important years in the world's history.

Though a large number of species are known, and though we have a very good idea of the general character of the fauna at different periods, the known species must be few in number in comparison to those which remain to be discovered.

In the last ten years the number of known types has been more than doubled, and one feels compelled from time to time to stop and take stock lest one gets overwhelmed with the multitude of forms.

In the following lists I have endeavoured to classify all the known reptiles of the Karroo. For many years it will be impossible to be certain of the validity of a few species founded on very imperfect remains. Fortunately most South African workers have been careful only to found species on skulls or good skeletal remains, and hence the confusion caused so frequently in America and Europe by having names given to vertebræ or limb bones scarcely exists with us, and the few such types as there are will be treated as they deserve to be.

As an Order can rarely, if ever, be as carefully defined when first proposed as a species or genus, it is impossible to apply the rules of nomenclature to the large groups. Doubtless it is right to commemorate the work of the pioneers by using the names proposed by them wherever possible, but it is quite impossible always to do so without causing hopeless confusion. For example, the name Cotylosauria was proposed by Cope in 1880 as a suborder of which *Diadectes* was the type. It was founded on an error and was given up. In 1889 it was re-established as an order to include the reptiles with roofed temporal regions. In 1888, however, Seeley had proposed the order Pareiasauria, and there has been much discussion and

difference of opinion as to which name has the priority and ought to be used. If the question is to be decided by strict priority then neither name must be used, but Owen's term Serratidentia, proposed in 1876 for the group to which *Pareiasaurus* belongs. As, however Owen believed *Pareiasaurus* to be a Dinosaur, and as no one has ever adopted Owen's term for the reptiles with a roofed temporal region it seems necessary to use one of the other two terms. As Seeley in 1888 manifestly did not mean his Pareiasauria to include any but *Pareiasaurus*-like animals and in his classification puts the Procolophonia and the Cotylosauria as other orders of equal value we can hardly use his term as a super-order. On the other hand, Cope in 1889 clearly made Cotylosauria an embracing order including all the primitive reptiles with roofed temporal regions. And as most later writers have continued to use Cope's term in this sense it seems best to use the term Cotylosauria as a super-order and to use the term Pareiasauria as a suborder of the Cotylosauria.

In the following list I have used the terms which seem to me those that have most claim. Very doubtful species I have omitted. Species that are a little doubtful but possibly good I have retained :—

P. indicates that the form is Permian ; T. Triassic ; and J. Jurassic.

Super-Order COTYLOSAURIA, Cope.

Order PAREIASAURIA, Seeley.

Pareiasaurus serridens, Owen .... P.
Pareiasaurus bombidens, Owen .... P.
Pareiasaurus baini, Seeley .... P.
Pareiasaurus russouwi, Seeley .... P.
Propappus omocratus, Seeley ...... P.
Propappus rogersi, Broom .... P.
Anthodon serrarius, Owen .... P.

Order PROCOLOPHONIA, Seeley.

Procolophon trigoniceps, Owen .... T.
Procolophon minor, Owen .... T.
Procolophon baini, Broom .... T.
Thelegnathus browni, Broom ...... T.
Thelegnathus parvus, Broom...... T.
Saurosternon baini, Huxley ...... ? T.

Super-Order THERAPSIDA, Broom.

Order DINOCEPHALIA, Seeley.

Tapinocephalus atherstonii, Owen.. P.
Delphinognathus conocephalus, Seeley P.
Pelosuchus priscus, Broom .... P.
Eccasaurus priscus, Broom........ P.
Moschops capensis, Broom .... P.
Tamboeria maraisi, Seeley........ P.
Taurops macrodon, Broom .... P.

Order DROMASAURIA, Broom.

Galechirus scholtzi, Broom........ P.
Galepus jouberti, Broom .... P.
Galeops whaitsi, Broom .... P.

Order THEROCEPHALIA, Broom.

Archæosuchus cairncrossi, Broom .. P.
Titanosuchus ferox, Owen .... P.

Titanosuchus cloetei, Broom ...... P.
Scapanodon duplessisi, Broom .... P.
Scymnognathus whaitsi, Broom .... P.
Gorgonops torvus, Owen .... P.
Alopecodon priscus, Broom .... P.
Alopecodon rugosus, Broom ...... P.
Lycosaurus pardalis, Owen ...... P.
Ictidosuchus angusticeps, Broom .. P.
Eriphostoma microdon, Broom .... P.
Lycosuchus vanderrieti, Broom.... P.
Lycosuchus mackayi, Broom ...... P.
Pardosuchus whaitsi, Broom ...... P.
Scymnosaurus ferox, Broom ...... P.
Scymnosaurus warreni, Broom .... P.
Glanosuchus macrops, Broom...... P
Trochosaurus acutus, Broom ...... P.
Hyænasuchus whaitsi, Broom .... P.
Scylacosaurus sclateri, Broom .... P.
Pristerognathus polyodon, Seeley .. P.
Pristerognathus baini, Broom .... P.
Pristerognathus platyrhinus, Broom P.
Lycorhinus parvidens, Broom .... P.
Ictidognathus parvidens, Broom .. P.
Ictidognathus hemburyi, Broom.... P.
Scaloposaurus constrictus, Owen .. P.
Aloposaurus gracilis, Broom ...... P.
Ælurosaurus felinus, Owen ...... P.
Ælurosaurus angusticeps, Broom .. P.
Ælurosaurus whaitsi, Broom...... P.
Ælurosaurus striatidens, Broom .. P.
Cynodraco serridens, Owen........ P.
Cynosuchus suppostus, Owen ...... P.
Tigrisuchus simus, Owen.......... P.
Cynochampsa laniaria, Owen...... P.
Arctosuchus tigrinus, (Owen) ...... P.
Arctognathus curvimola, (Owen) .. P.
Ictidosuchus primævus, Broom .... P.
Arnognathus parvidens, Broom .... P.

Order ANOMODONTIA, Owen.

Endothiodon bathystoma, Owen .. P.
Endothiodon uniseries, Owen...... P.
Endothiodon whaitsi, Broom...... P.
Endothiodon platyceps, Broom .... P.
Cryptocynodon simus, Seeley ...... P.
Pristerodon mackayi, Huxley...... P.
Pristerodon agilis, (Broom) ...... P.
Pristerodon brachyops, (Broom) .. P.
Taognathus megalodon, Broom .... P.
Diælurodon whaitsi, Broom ...... P.
Prodicynodon pearstonensis, Broom P.
Prodicynodon beaufortensis, Broom P.
Chelyoposaurus williamsi, Broom.. ? P.
Dicynodon lacerticeps, Owen...... ? T.
Dicynodon feliceps, Owen .... P.
Dicynodon testudiceps, Owen ...... P.
Dicynodon tigriceps, Owen........ P.
Dicynodon leoniceps, Owen ...... P.
Dicynodon pardiceps, Owen ...... P.
Dicynodon recurvidens, Owen .... P.
Dicynodon magnus, (Owen) ...... P.
Dicynodon curvatus, Owen ....? T.
Dicynodon brevirostris, (Owen).... P.
Dicynodon prognathus, (Owen).... P.
Dicynodon grayi, (Owen) .... P.
Dicynodon megalops, (Owen) ...... P.
Dicynodon strigiceps, (Owen)...... ? T.
Dicynodon raniceps, (Owen) ...... P.
Dicynodon simocephalus, Weithofer T.
Dicynodon latifrons, Broom ...... T.
Dicynodon truncatus, (Broom) .... ? P.
Dicynodon gracilis, (Broom) ...... P.
Dicynodon trigoniceps, (Broom).... P.
Dicynodon megalorhinus, (Broom).. P.
Dicynodon jouberti, Broom........ P.
Dicynodon ingens, Broom .... ? T.
Dicynodon bolorhinus, (Broom).... P.
Dicynodon kolbei, (Broom)........ P.
Dicynodon laticeps, Broom........ P.
Dicynodon psittacops, Broom ...... P.
Dicynodon lutriceps, Broom ...... P.
Dicynodon pachyrhynchus, Jaekel ? T.
Emydops arctatus, (Owen) .... P.
Emydops minor, Broom .... P.
Lystrosaurus frontosus, Cope...... T.
Lystrosaurus declivis, (Owen) .... T.
Lystrosaurus latirostris, (Owen) .. T.
Lystrosaurus murrayi, (Huxley) .. T.
Lystrosaurus boopis, (Owen) ...... T.
Lystrosaurus maccaigi, (Seeley) .. T.
Lystrosaurus platyceps, (Seeley) .. T.
Lystrosaurus andersoni, Broom .. ? T.
Cistecephalus microrhinus, Owen .. P.

Order CYNODONTIA, Owen.

Galesaurus planiceps, Owen ...... T.
Nythosaurus larvatus, Owen ...... T.
Nythosaurus browni, Broom ...... T.
Ictidopsis elegans, Broom .... T.
Cynognathus crateronotus, Seeley.. T.

Cynognathus berryi, Seeley ...... T.
Cynognathus platyceps, Seeley .... T.
Cynognathus seeleyi, Broom ...... T.
Ælurosuchus browni, Broom ...... T.
Microgomphodon oligocynus, Seeley T.
Trirachodon kannemeyeri, Seeley .. T.
Trirachodon berryi, Seeley........ T.
Trirachodon minor, Broom ...... T.
Diademodon mastacus, Seeley .... T.
Diademodon tetragonus, Seeley .... T.
Diademodon browni, Seeley ...... T.
Gomphognathus kannemeyeri, Seeley T.
Gomphognathus polyphagus, Seeley T.
Sesamodon browni, Broom........ T.
Melinodon simus, Broom .... T.
Tritheledon riconoi, Broom ...... J.
Bauria cynops, Broom .... T.
Tribolodon frerensis, Seeley ...... T.
Karoomys browni, Broom .... T.

Super-Order DIAPTOSAURIA, Osborn.

Order PROGANOSAURIA, Baur.

Mesosaurus tenuidens, Gervais .... P.
Mesosaurus pleurogaster, Seeley .. P.
Mesosaurus capensis (Gürich) .... P.
Noteosaurus africanus, Broom .... P.

Order THECODONTIA, Owen.

Heleosuchus griesbachi, (Owen).... ? P.
Heleosaurus scholtzi, Broom ...... P.
Heleophilus acutus, Broom........ P.
Eosuchus colletti, Watson .... T.
Proterosuchus fergusi, Broom .... T.
Mesosuchus browni, Watson ...... T.
Erythrosuchus africanus, Broom .. T.

Order CROCODILIA.

Notochampsa istedana, Broom .. . J.
Notochampsa longipes, Broom .... J.

Order DINOSAURIA, Owen.

Sub-Order THEROPODA, Marsh.

Massospondylus carinatus, Owen .. J.
Massospondylus harriesi, Broöm .. J.
Euskelesaurus browni, Huxley .... J.
Euskelesaurus capensis, (Lydekker) J.
Gryponyx africanus, Broom ...... J.
Gryponyx transvaalensis, Broom .. J.
Ætonyx palustris, Broom .... J.
Thecodontosaurus skirtopodus, (Seeley) .... J.
Thecodontosaurus browni, (Seeley) J.
Gyposaurus capensis, Broom ...... J.

Sub-Order PREDENTATA, Marsh.

Geranosaurus atavus, Broom .... J.

Order RHYNCHOCEPHALIA, Günther.

Palacrodon browni, Broom........ T.

Order GNATHODONTIA, Owen.

Howesia browni, Broom .... T.

Order LACERTILIA.

Paliguana whitei, Broom .... T.

Super-Order CHELONIA.

Eunotosaurus africanus, Seeley .. P.

Of the above recognised 168 types all are known by skull remains except 16, and of these 9 are Dinosaurs.

In the above classification it must not be considered that finality has been reached. In dealing with extinct forms which are often very imperfectly known it is impossible to do more than place many of them in the system provisionally. Attention may be called to the following points :—

Gorgonops, *Titanosuchus*, and the allied forms are provisionally placed in the Therocephalia, of which they form a distinct family.

The genera *Oudenodon* and *Opisthoctenodon* have been abandoned as these supposed genera are now pretty certainly known to be the females of *Dicynodon* and *Pristerodon* respectively, the presence or absence of a tusk being evidently only a sexual character in these types.

Karoomys, which I have hitherto regarded as probably a mammal, is perhaps rather more likely to be a Cynodont.

Under Owen's order Thecodontia are grouped a series of primitive reptiles which seem to be connected with the ancestral crocodiles. The forms known probably belong to at least four sub-orders, but it seems unwise to attempt any further classification at present. *Helcosuchus griesbachi* is Owen's *Saurosternon griesbachi* which is, in my opinion, not at all allied to *Saurosternon baini*. *Erythrosuchus*, when first described by me, was regarded as a Phytosaur. At that time only a few bones of the skeleton had been discovered ; now the skull and most of the skeleton are known. Huene has recently discussed the affinities at length, and forms for the type a new Order, the Pelycosimia, believing it has affinities with the Pelycosaurs as well as the Phytosaurs. In this I differ from him. *Erythrosuchus* is, in my opinion, an ancestral Phytosaur not yet specialised for an aquatic life, and related to the *Belodon* types in much the same way as the Theropodous Dinosaurs are to the Sauropodous or the Creodonts to the Archæoceti. *Mesorhinus* of Jaekel to some extent forms a connecting link.

Eunotosaurus of Seeley I have placed in the Chelonia. The skull and limbs are still unknown, but the eight pairs of broad ribs and the structure of the vertebræ seem to suggest that we have here an ancestral Chelonian. Three specimens are known, all from the *Pareiasaurus* zone or Middle Permian beds.

Addendum [see next page].

ADDENDUM.

Since the above list was drawn up the following new Reptiles have been described :—

Order PAREIASAURIA.

Pareiasaurus acutirostris, Broom.
Pareiasuchus peringueyi, Broom and Haughton.
Propappus parvus, Haughton.

Orders THEROCEPHALIA and GORGONOPSIA.

Scylacops capensis, Broom.
Scymnognathus tigriceps, Broom and Haughton.
Scylacognathus parvus, Broom.
Scymnorhinus planiceps, Broom.

Order ANOMODONTIA.

Dicynodon alticeps, Broom and Haughton.
Dicynodon testudirostris, Broom and Haughton.
Dicynodon strigops, Broom.

Order THECODONTIA.

Euparkeria capensis, Broom.

It has been thought well to re-establish Seeley's Order or Sub-Order *Gorgonopsia*, as *Gorgonops* and its allies are now known to differ from the Therocephalians in many important points.

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